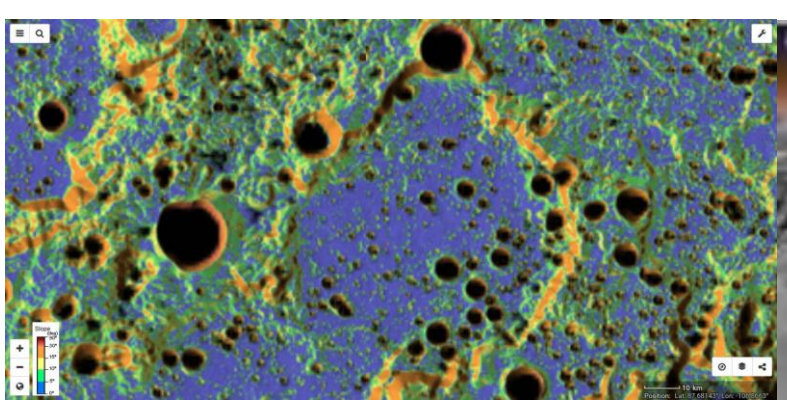
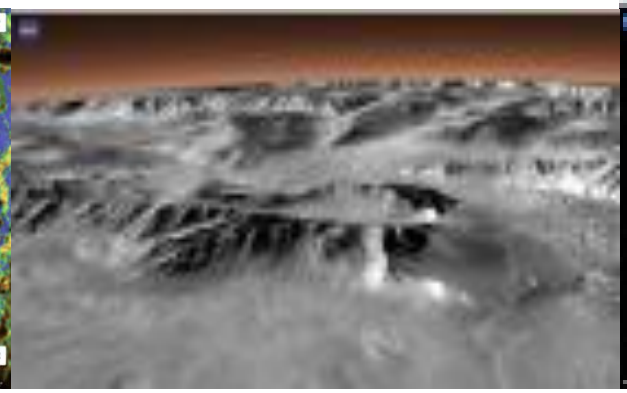
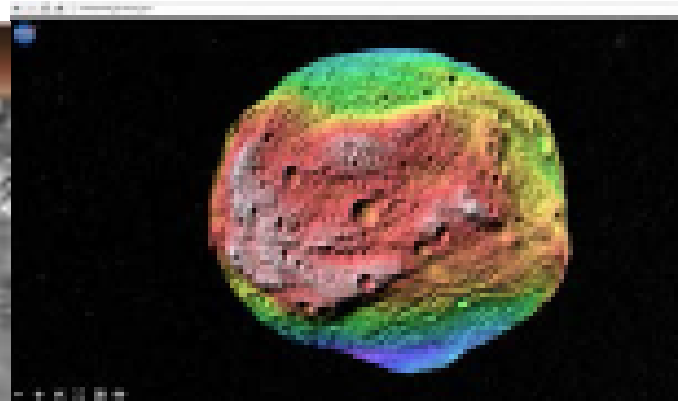
NASA Solar System Trek Portals for Lunar and Planetary Mapping and Modeling

Brian H. Day – SSERVI – brian.h.day@nasa.gov

JPL Development Team:
Emily Law, Eddie Arevalo, Bach Bui, George Chang,
Natalie Gallegos, Richard Kim, Shan Malhotra, Syed Sadaqathullah,
Dan Yu, Quoc Vu







Overview

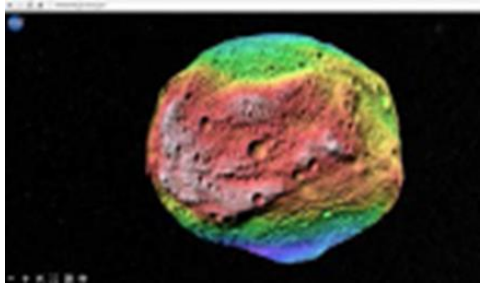
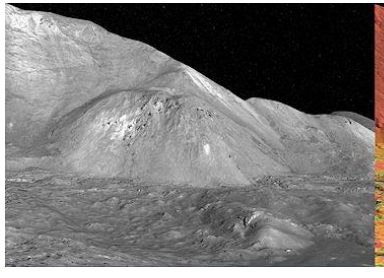
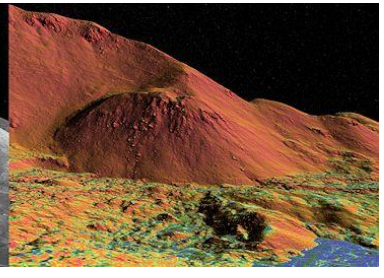
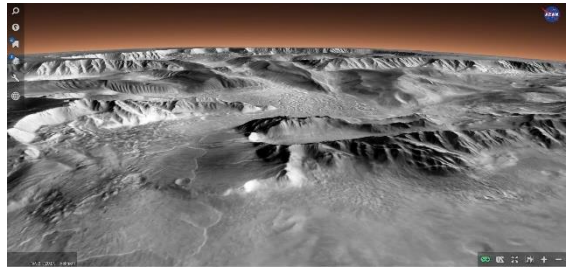
Planetary Mapping and Modeling - Solar System TREKS

- An integral project within NASA's Solar System Exploration Research Virtual Institute (SSERVI), managed out of the SSERVI Central Office, and with software development and operations at JPL

- A set of data products, interactive tools and technology for exploration
  - Mission Planning
  - Scientific Research
  - Public Outreach

- Online, browser-based Web portal; nothing to install

- Visualization, Analysis, 3D Printing, Data Service
  - A variety of user interfaces (e.g., virtual reality goggles)
  - A variety of external platforms (e.g,. Eyes on Solar System, planetariums)
  - Applicable to a wide range of target bodies

From LMMP to Moon Trek

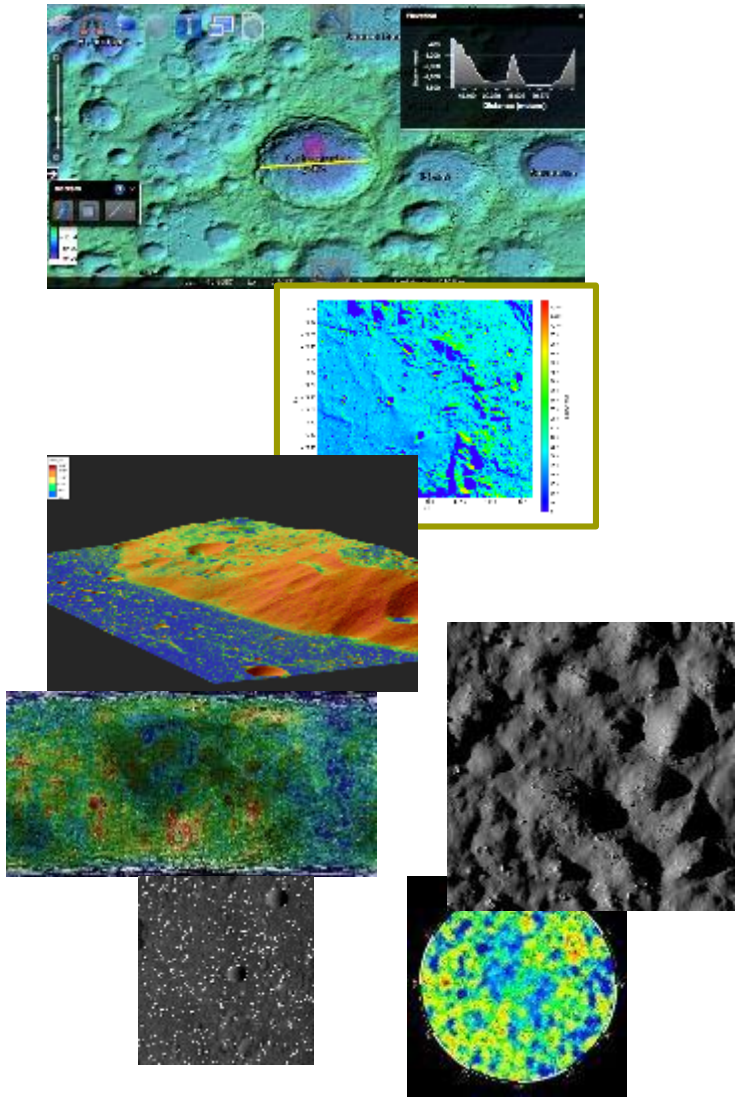
https://moontrek.jpl.nasa.gov

A New Look at the Moon:

- Moon Trek is a major new release that significantly upgrades and builds upon the capabilities of its predecessor, NASA's Lunar Mapping and Modeling Portal (LMMP).
- Greatly improved navigation, 3D visualization, fly-overs, performance, and reliability.
- Compatibility with the other Trek portals developed by NASA's Lunar and Planetary Mapping and Modeling Project.
- Designed for mission planning, lunar science, education and public outreach
- New 3D globe view uses standard keyboard game controls, for detailed fly-overs, and generating views from whatever angle and location the user desires.

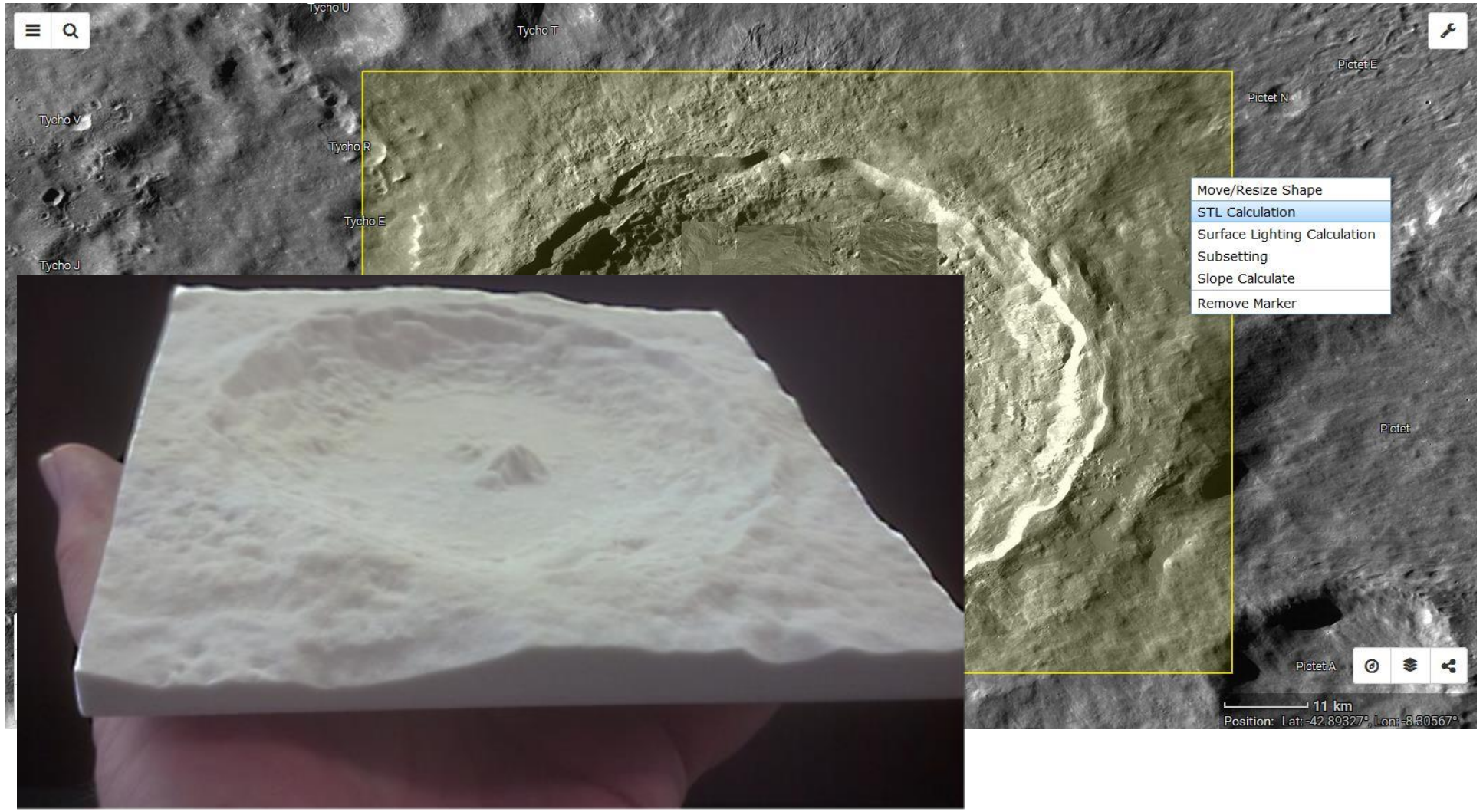
Moon Trek

- Analysis tools
  - Lighting, Slope, Hazard, Profile, Sun angle
- Browse, search and download of data products
- Visualization (with overlays)
- Collaboration (bookmark)
- 3D print and terrain view
- Data
  - LRO, Apollo, LP, GRAIL, Clementine, Chandrayaan-1, Kaguya
  - Gravity models, Imagery, DEMs, Hazards, Resources
- Users
  - Missions, Lunar scientists, EPO



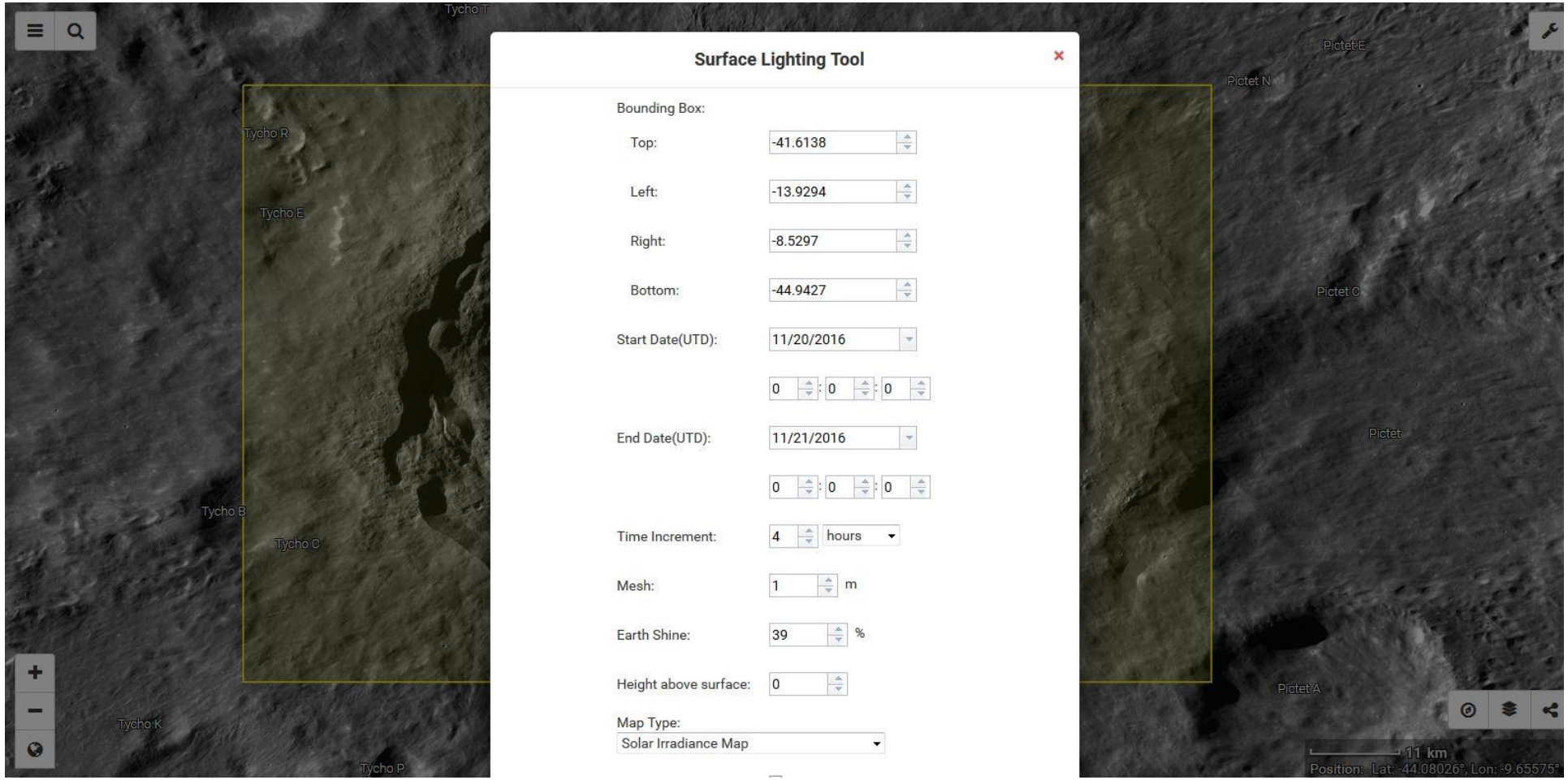
Insert MoonIntro movie here.

STL Generation



Insert Moon3D movie here.

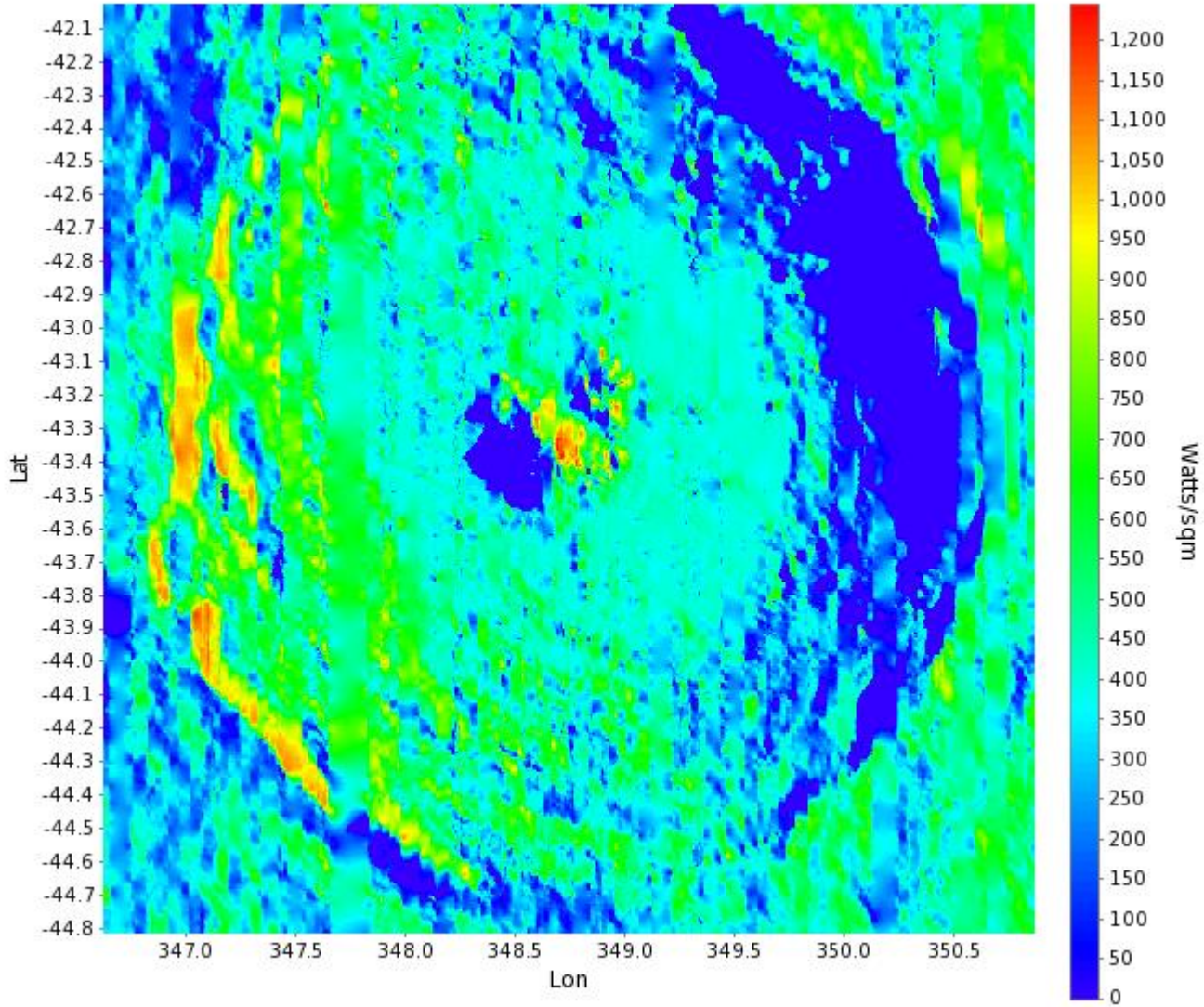
Lighting Analysis



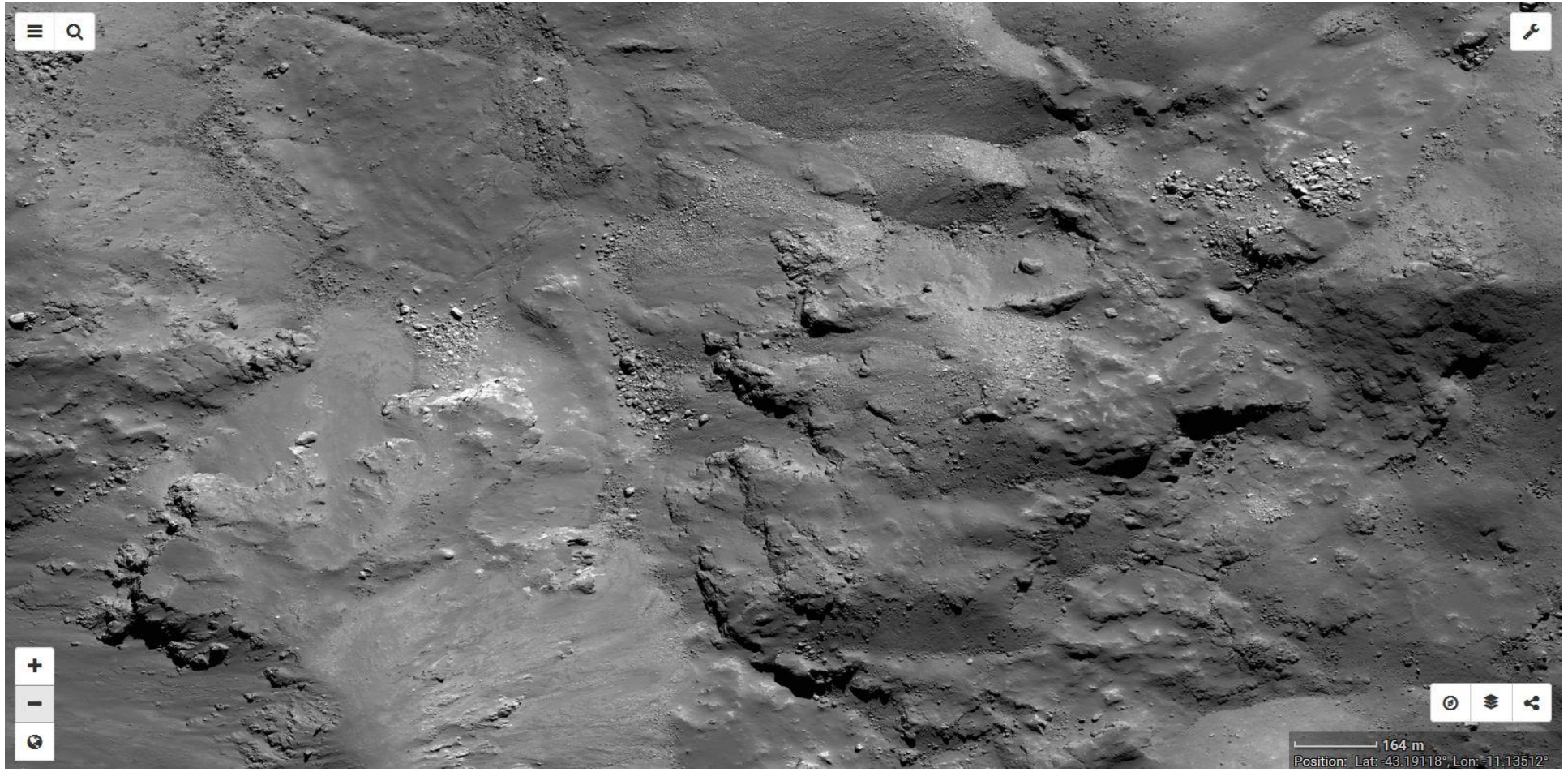
Lighting Analysis

Insert Lighting movie here.

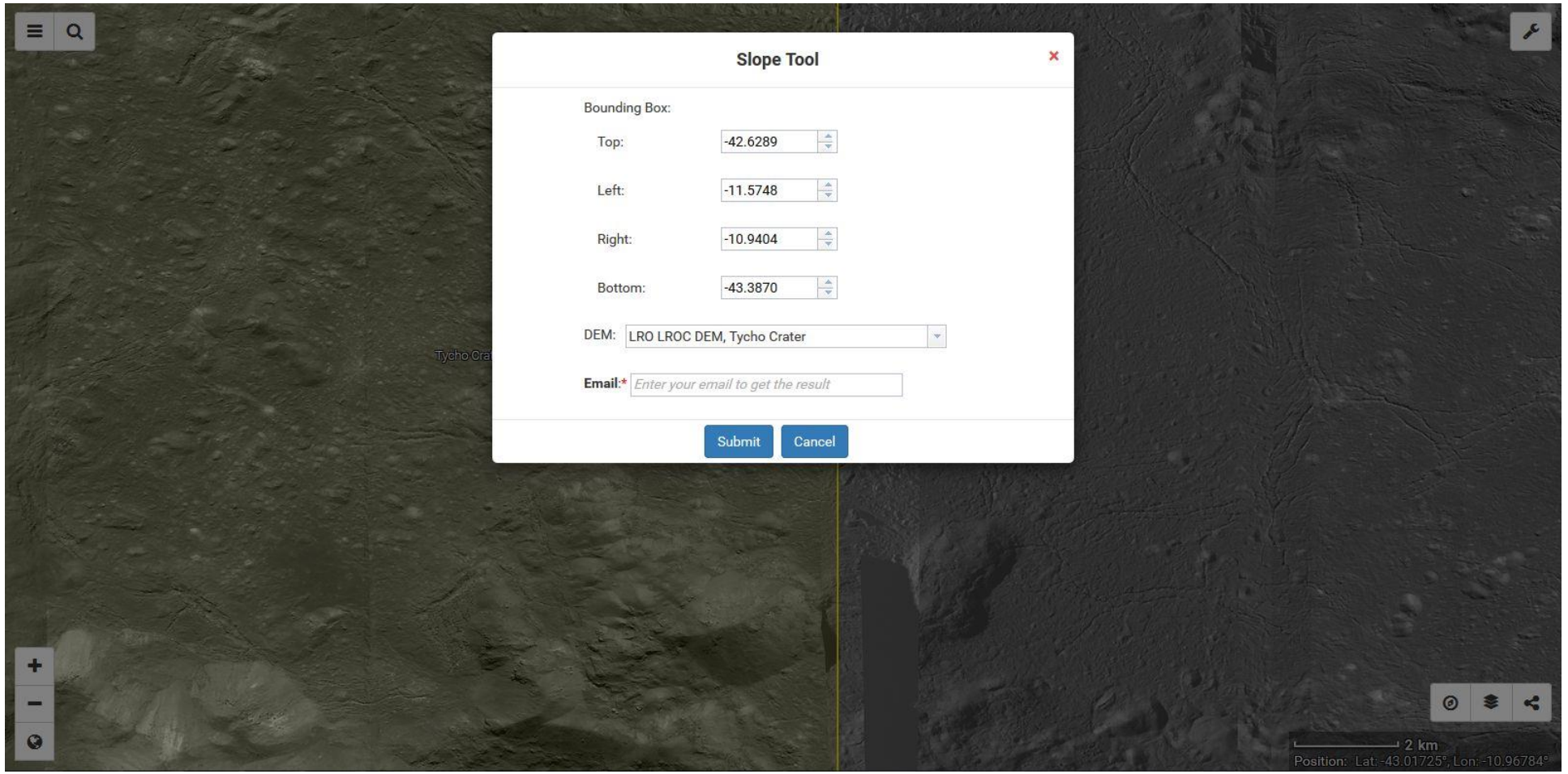
Lighting Analysis



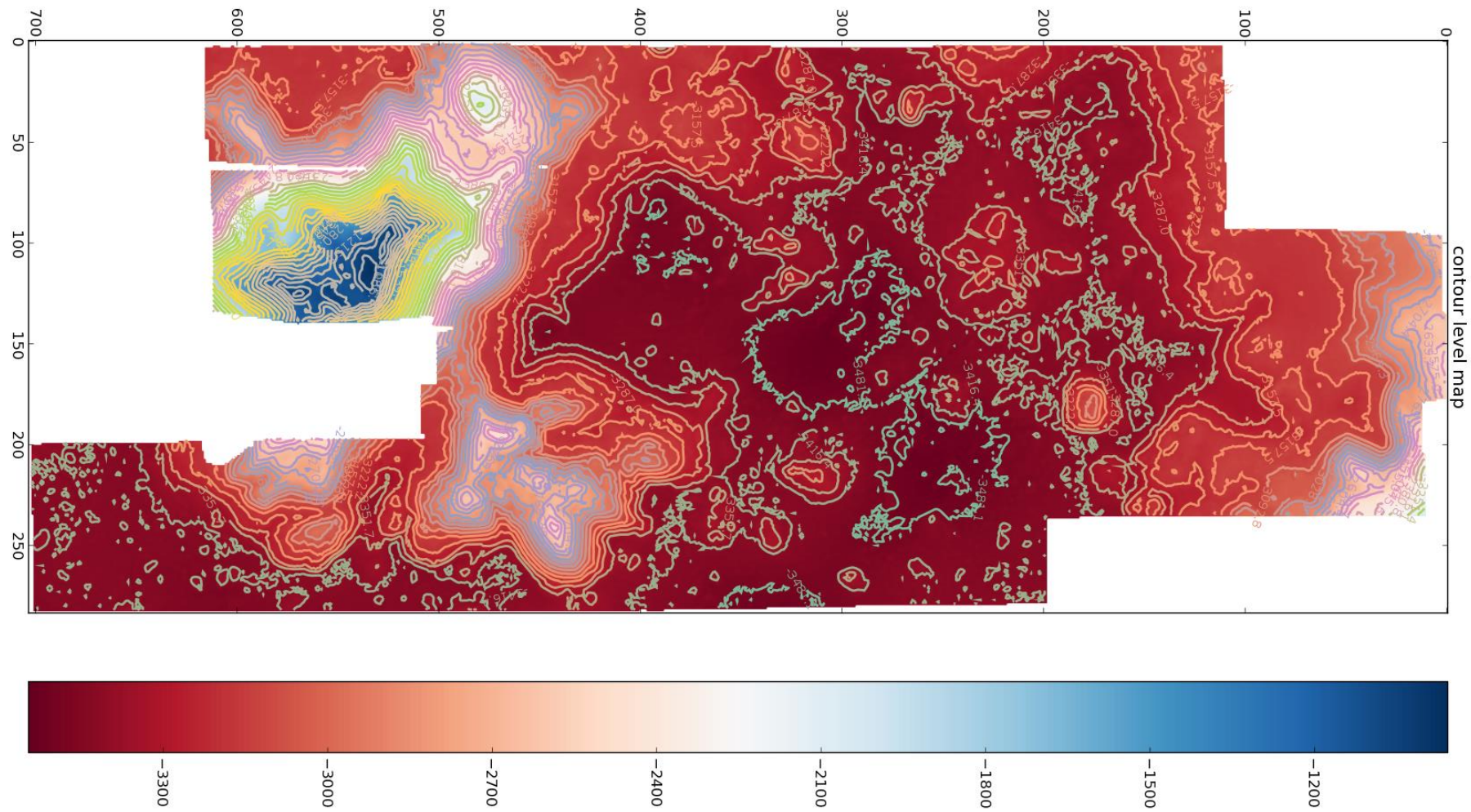
NAC Mosaic of Tycho Crater



Slope Tool


Slope Tool
Bounding Box:
Top:
-42.6289
Left:
-11.5748
Right:
-10.9404
Bottom:
-43.3870
DEM:
LRO LROC DEM, Tycho Crater
Email:*
Enter your email to get the result
Submit
Cancel
2 km
Position: Lat: -43.01725°, Lon: -10.96784°

Slope Tool


700
600
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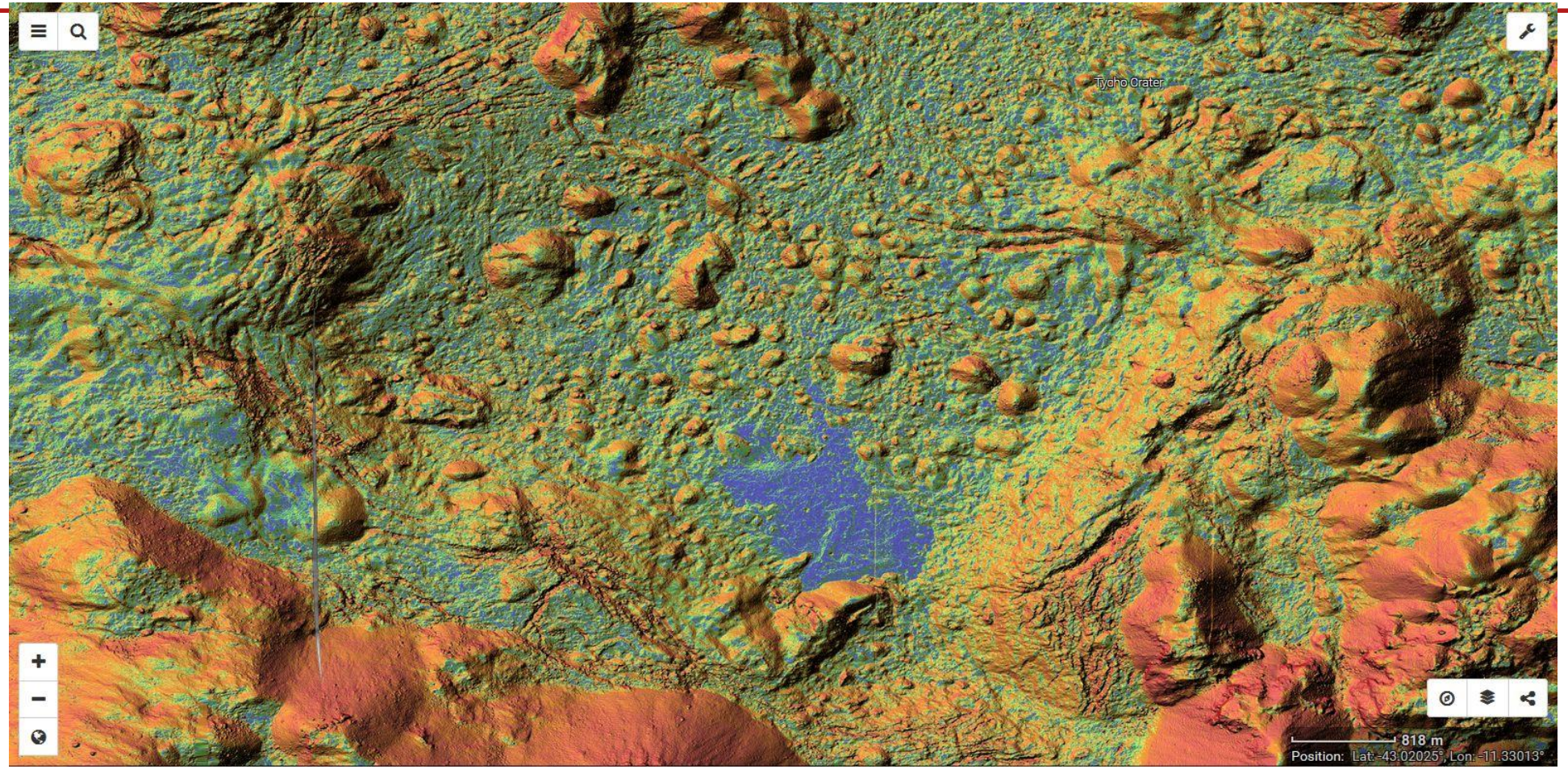
400
300
200
100
0
0
50
100
150
200
250
contour level map
−3300
−3000
−2700
−2400
−2100
−1800
−1500
−1200

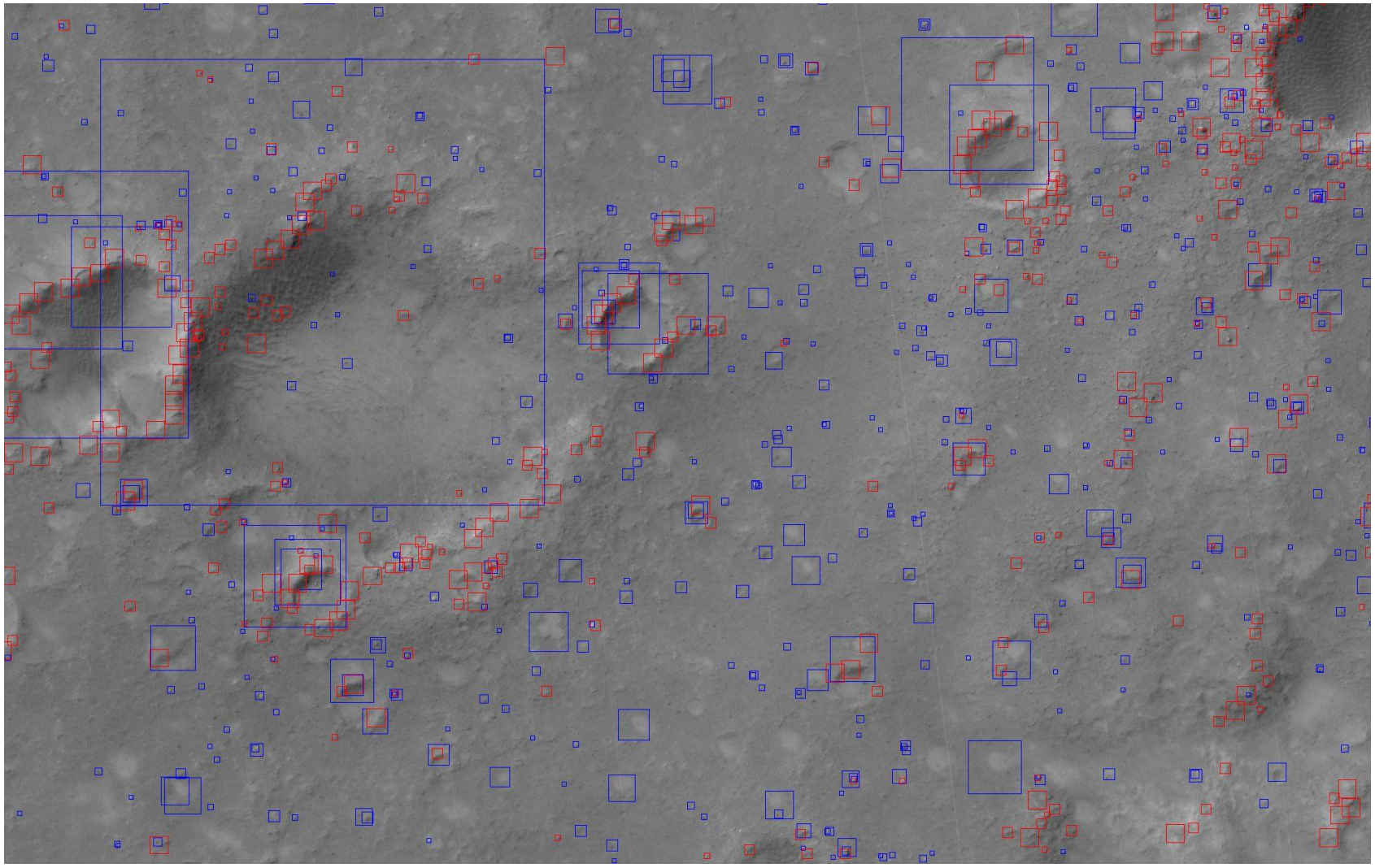
Slope Maps (and More)



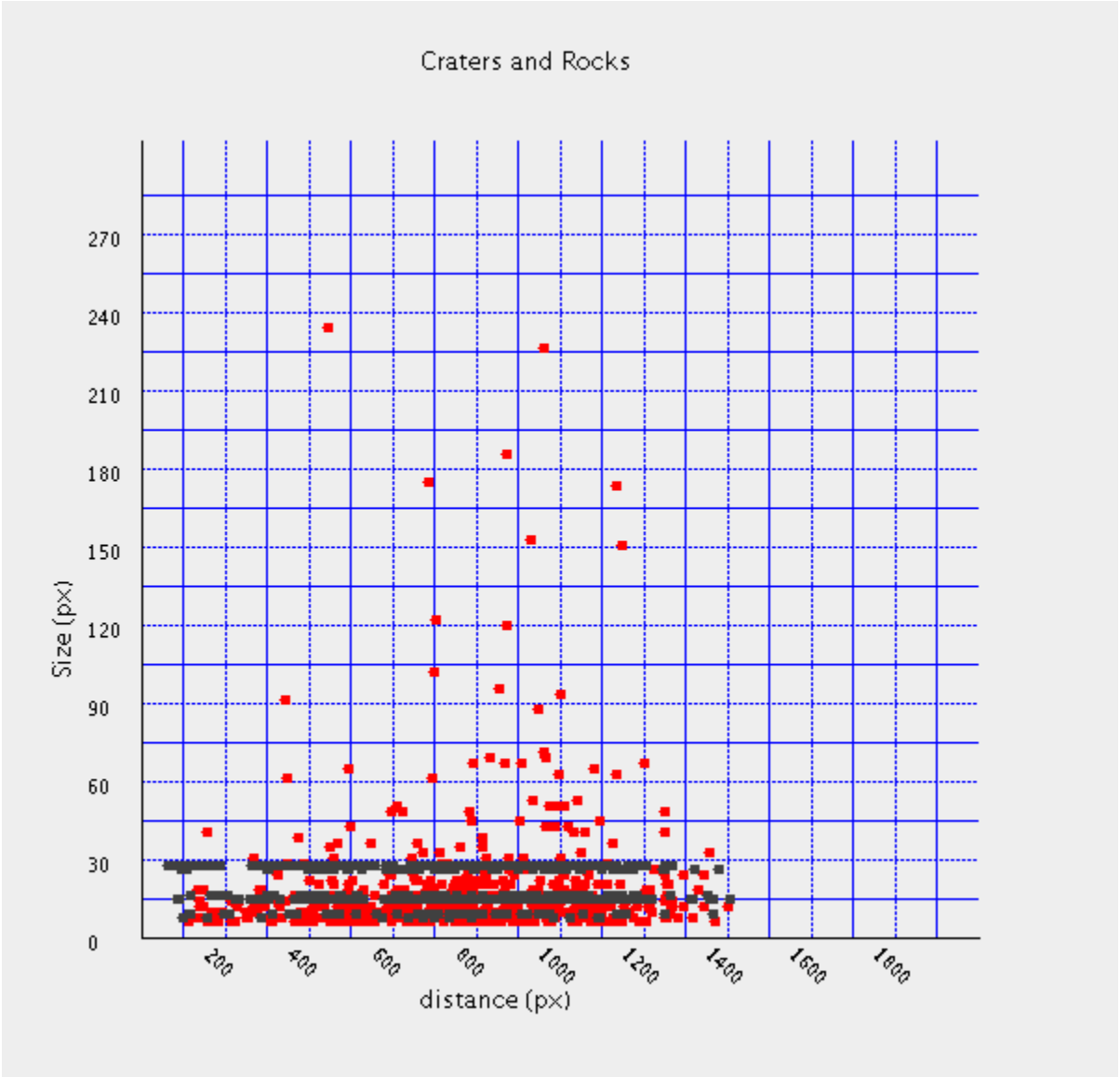
More Analysis Tools Coming Soon

- Crater Detection/Abundance
- Rock Detection/Abundance
- Electric Surface Potential Analysis (SSERVI PI Bill Farrell)
- Path Tool

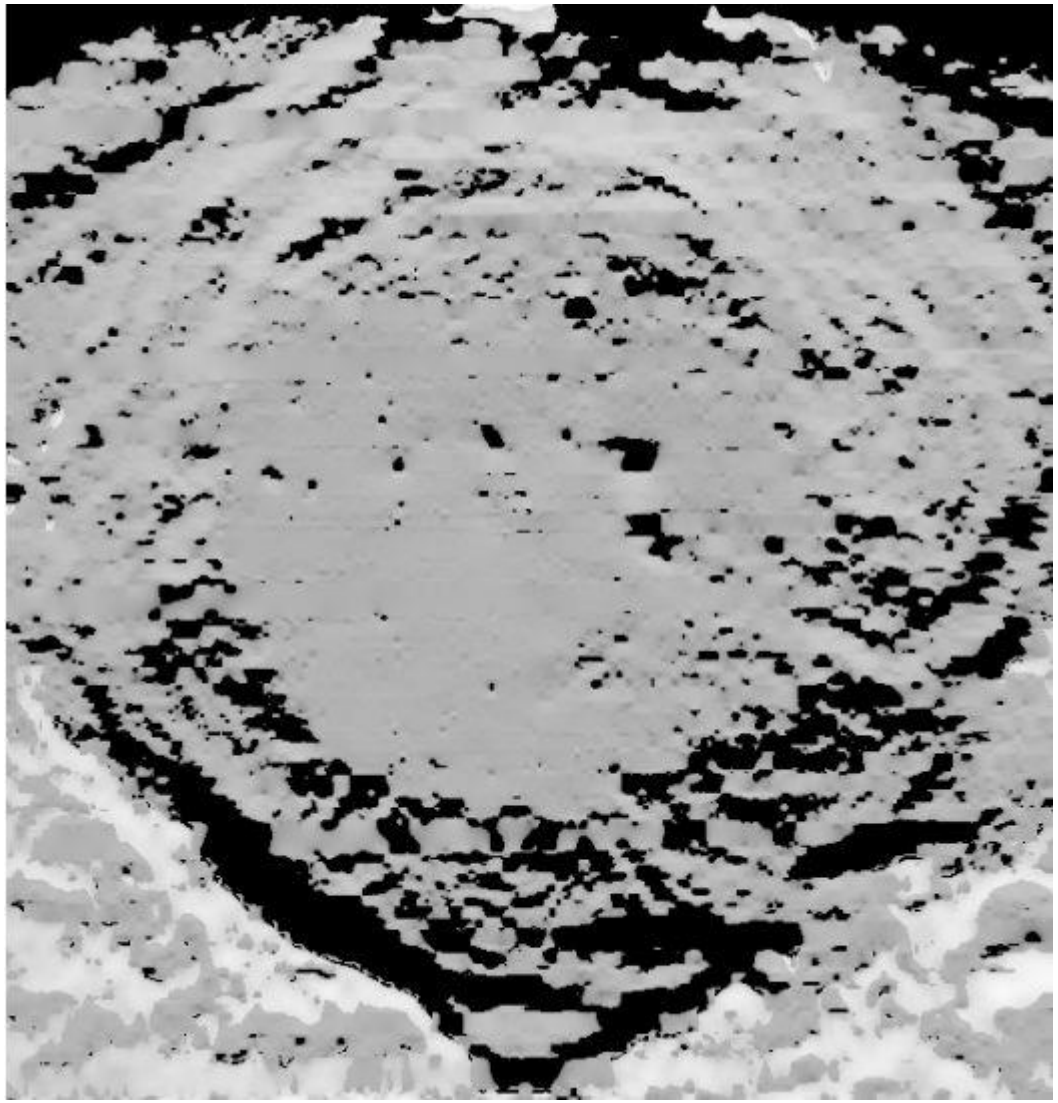
Crater/Rock Detection



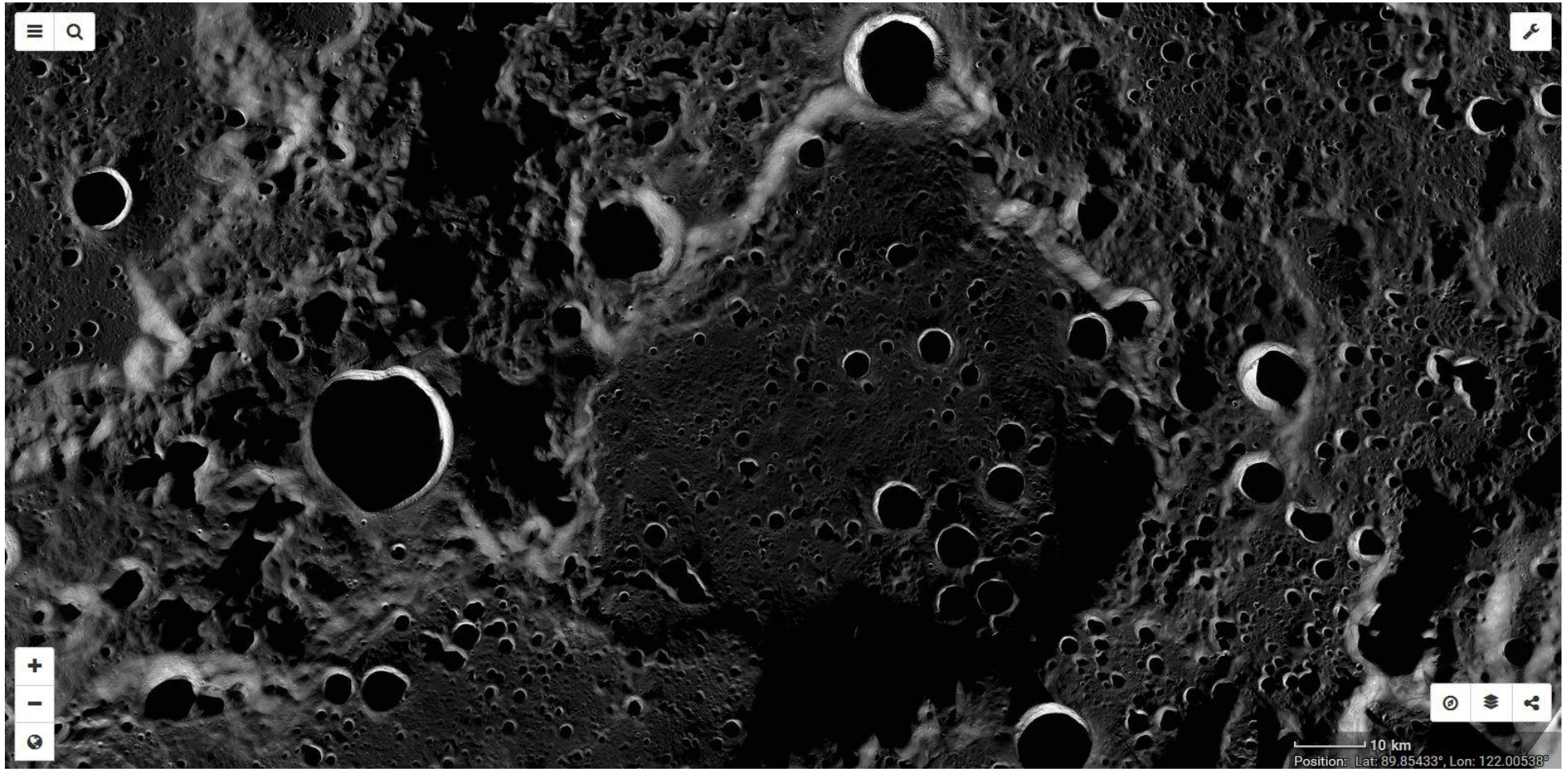
Crater/Rock Detection



Surface Potential Analysis

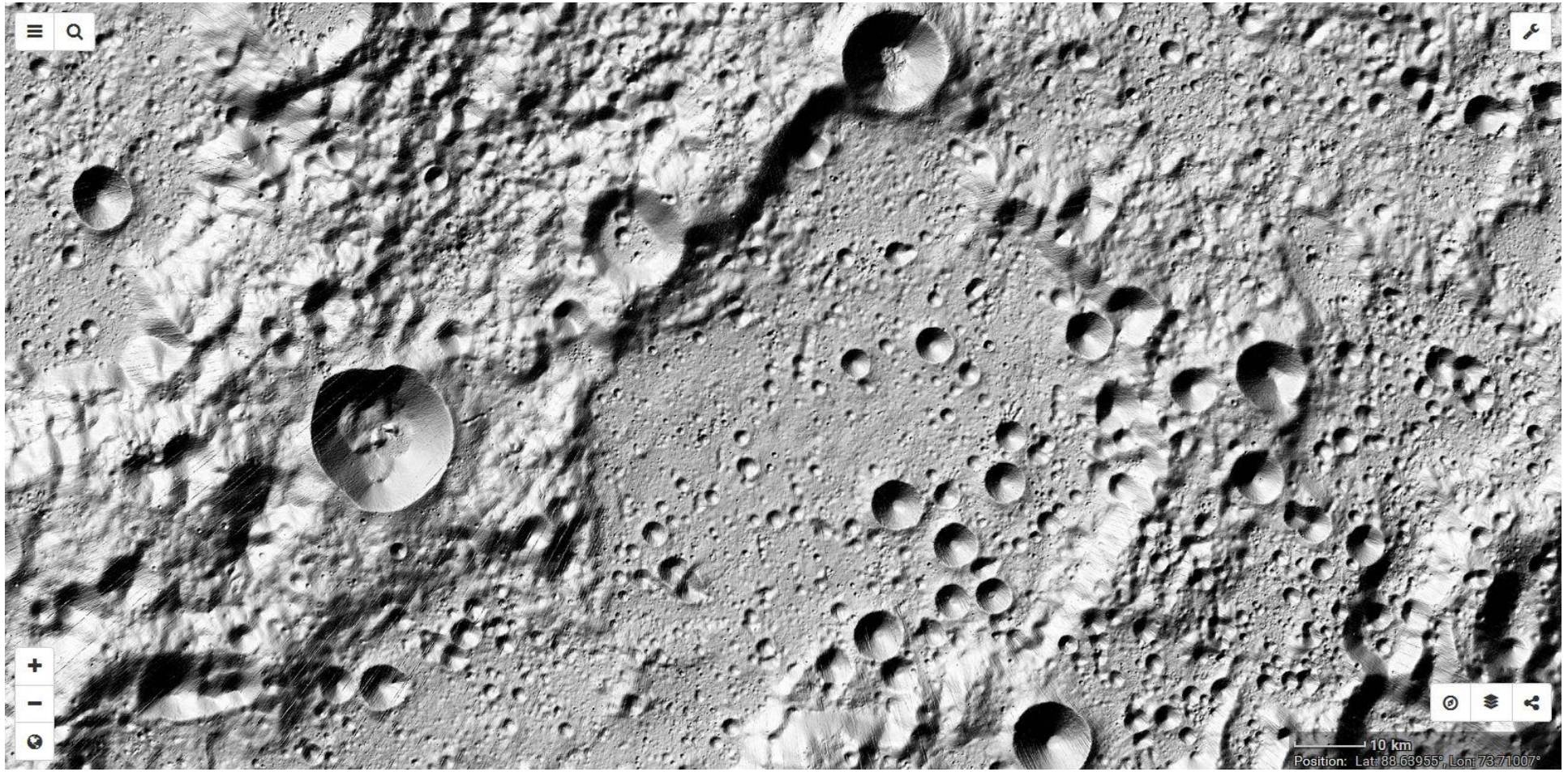


North Pole



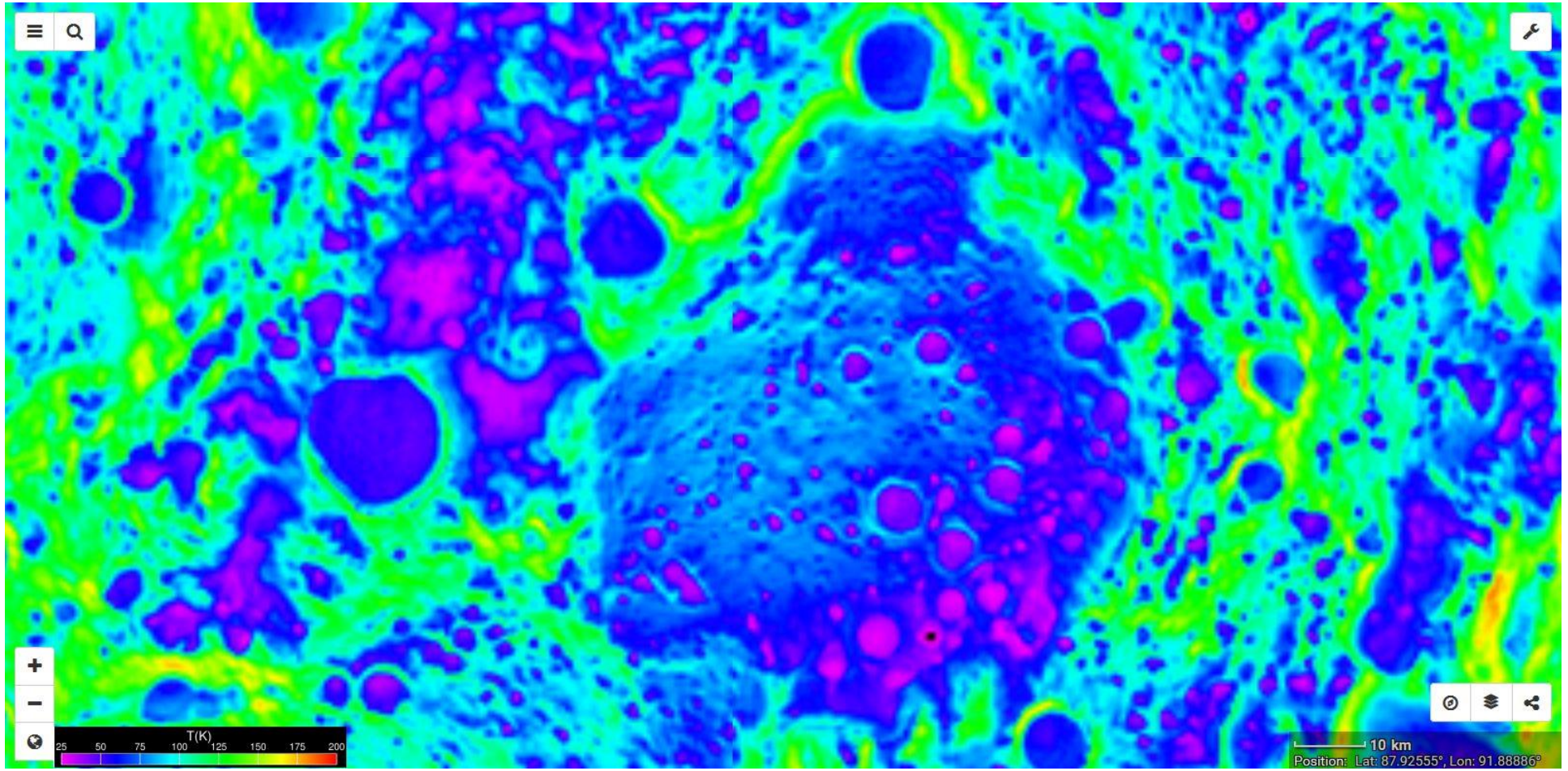
LRO NAC Mosaic

North Pole



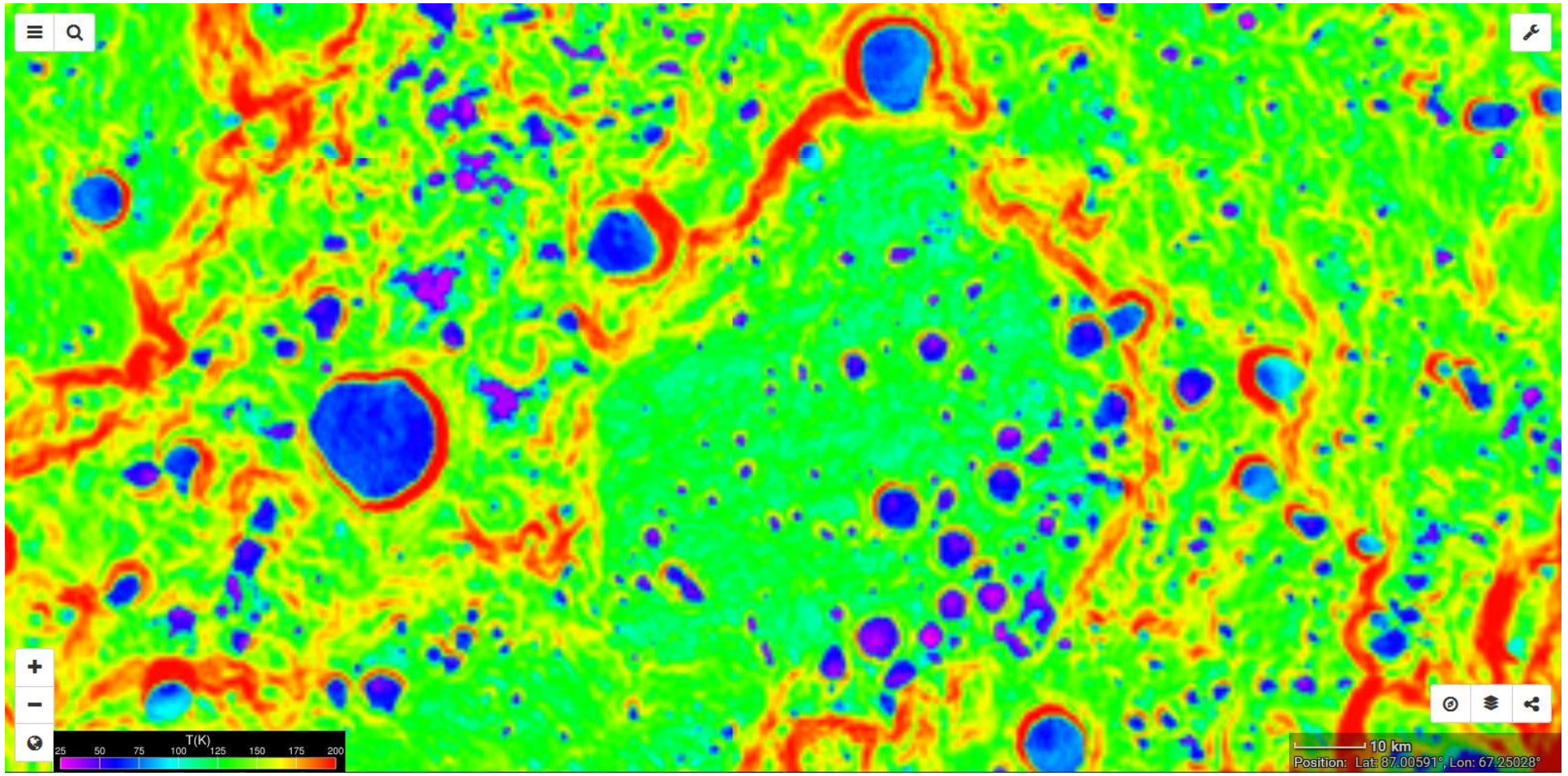
LRO LOLA Laser Altimetry

North Pole



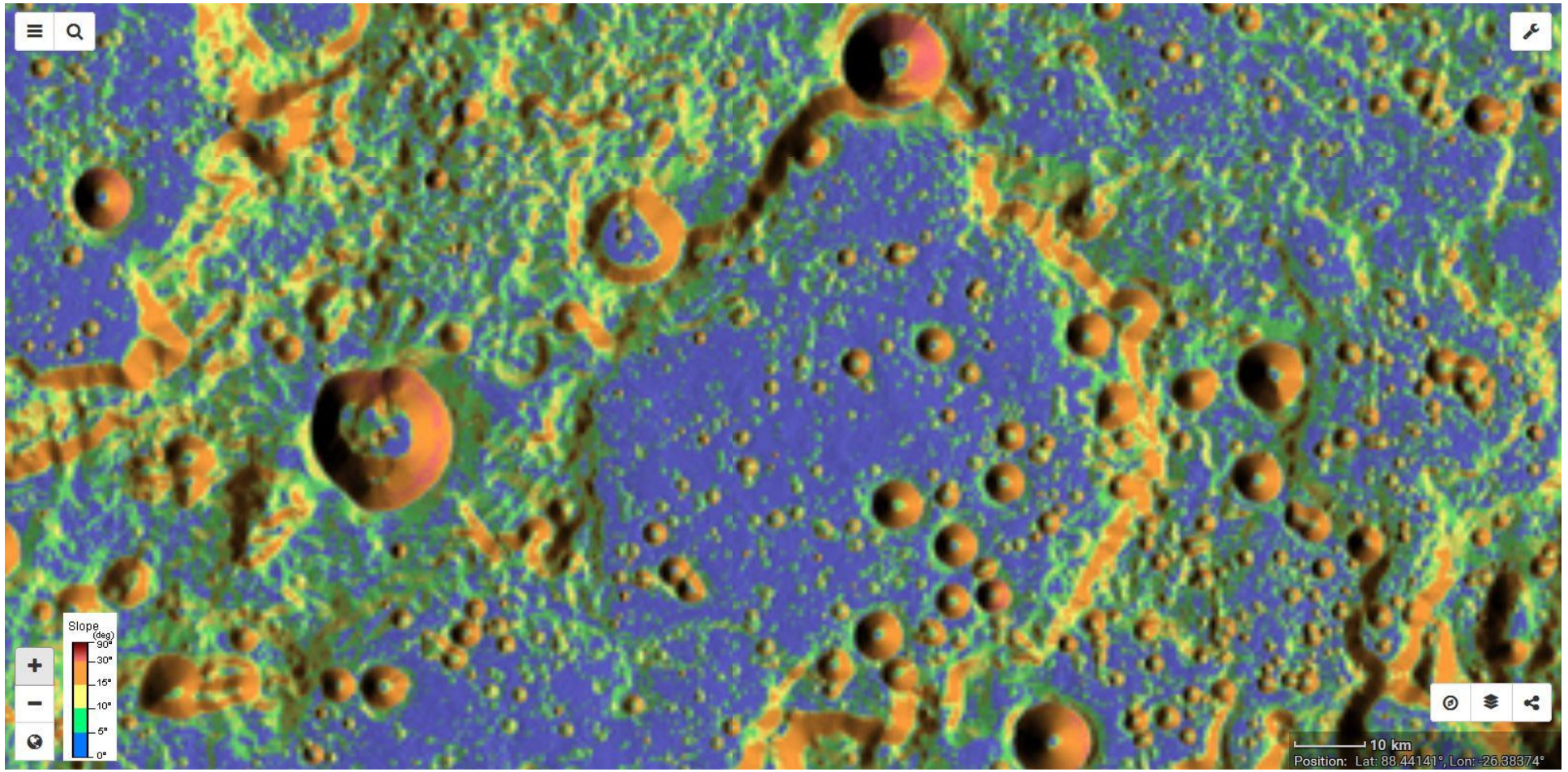
LRO DIVINER Average Temperature

North Pole



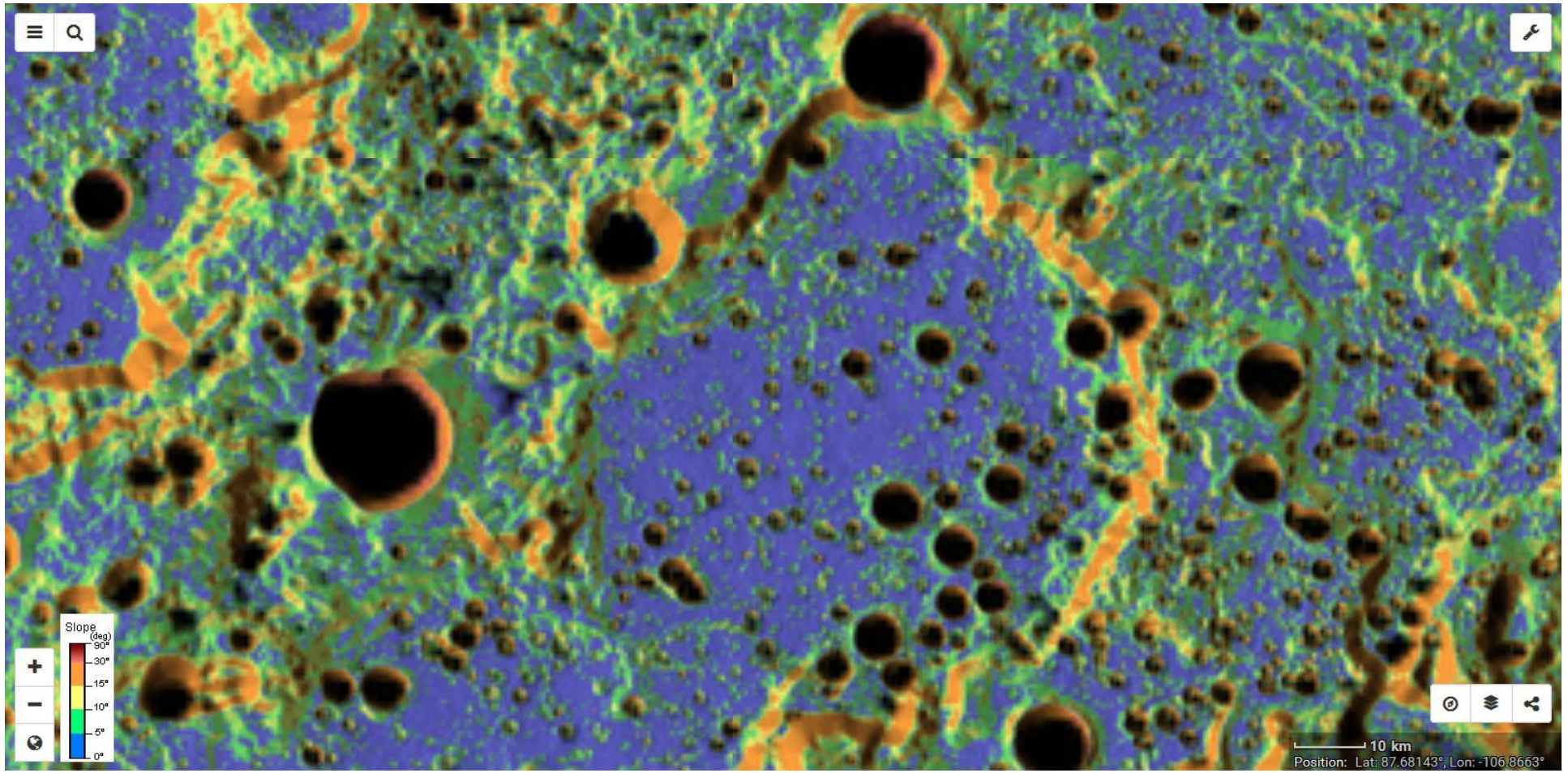
LRO DIVINER Maximum Temperature

North Pole



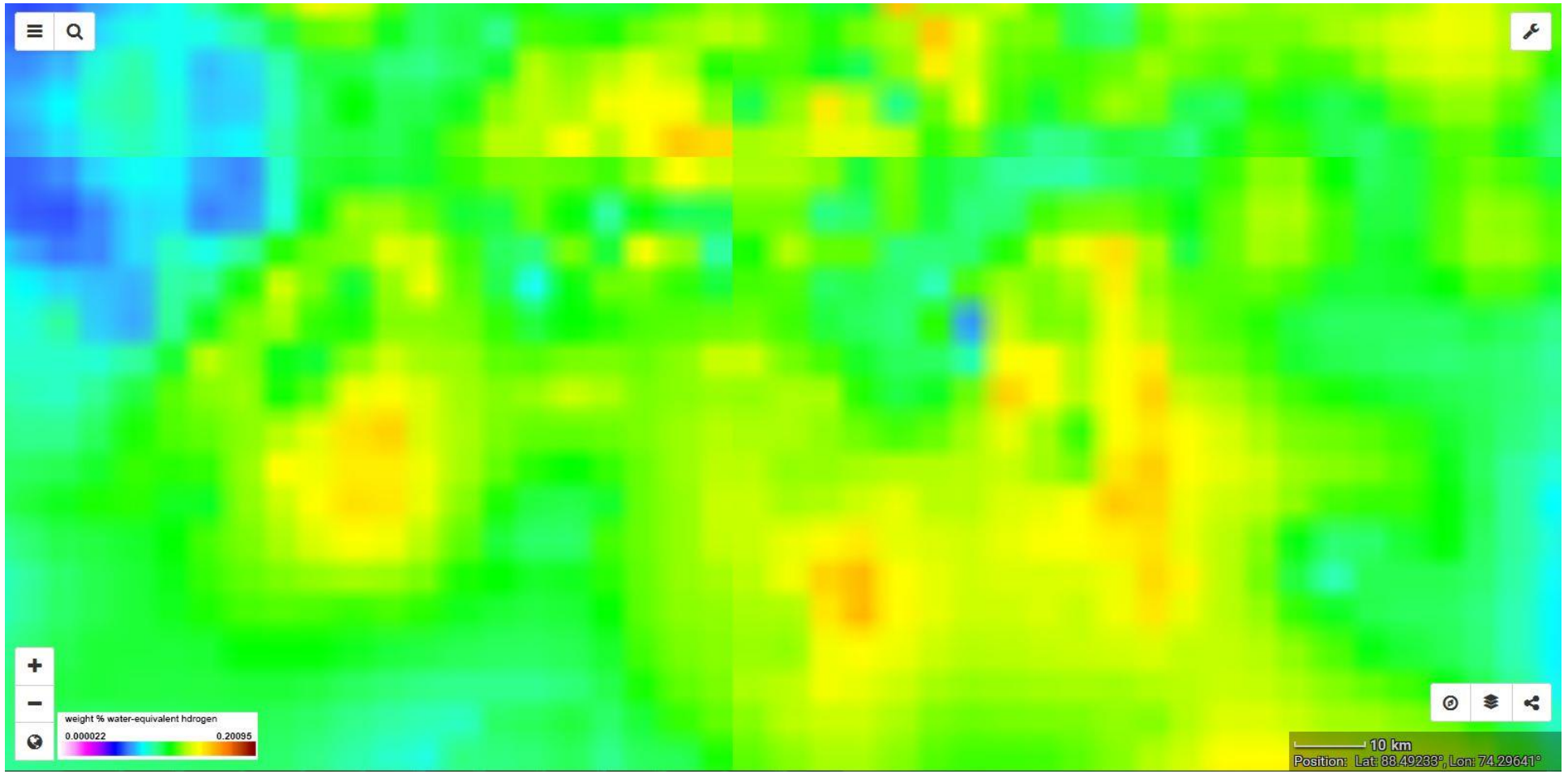
LRO LOLA Slope Map

North Pole



LOLA Permanently Shadowed Regions

North Pole

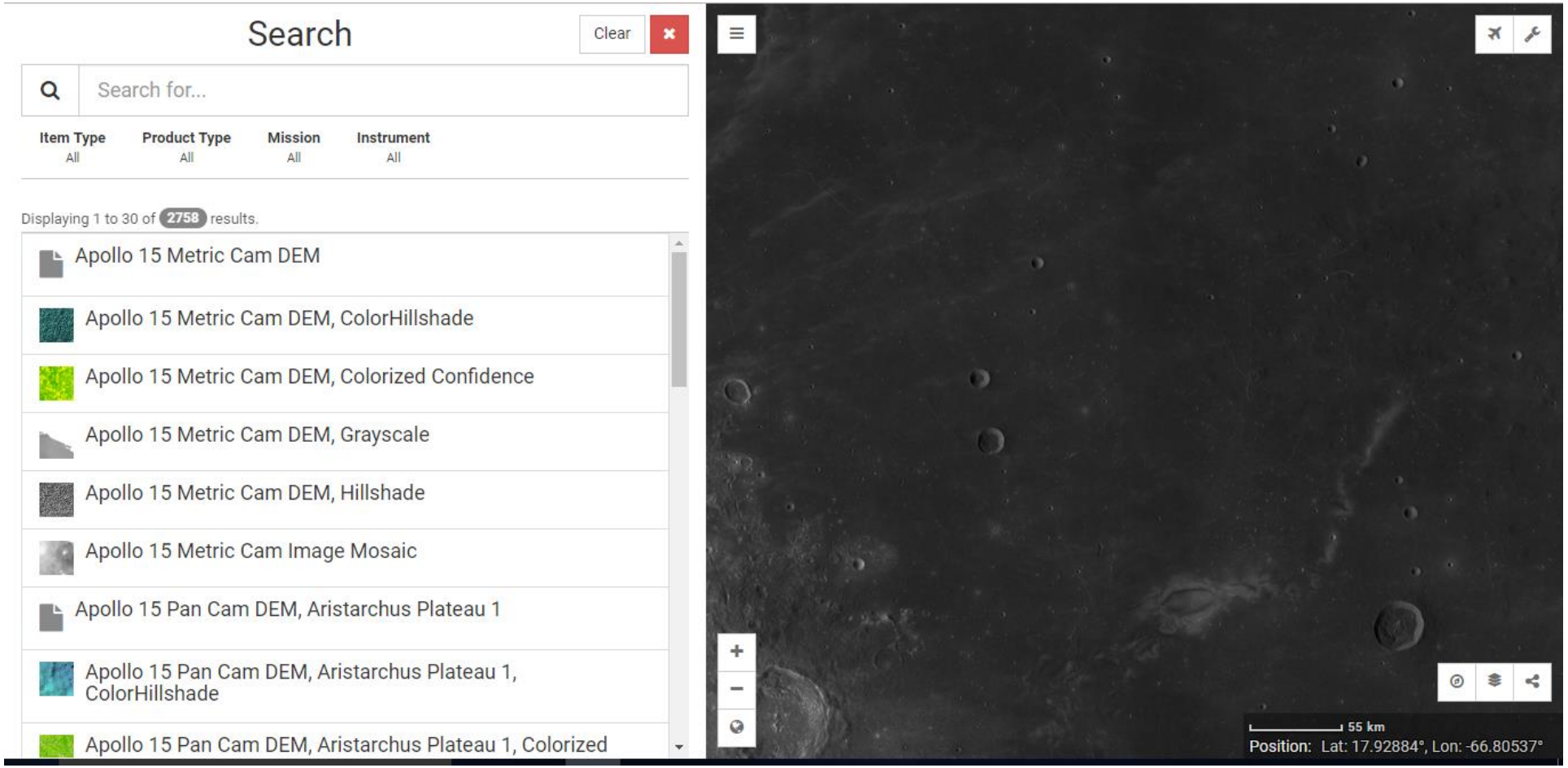


Hydrogen Abundance

The Marius Hills

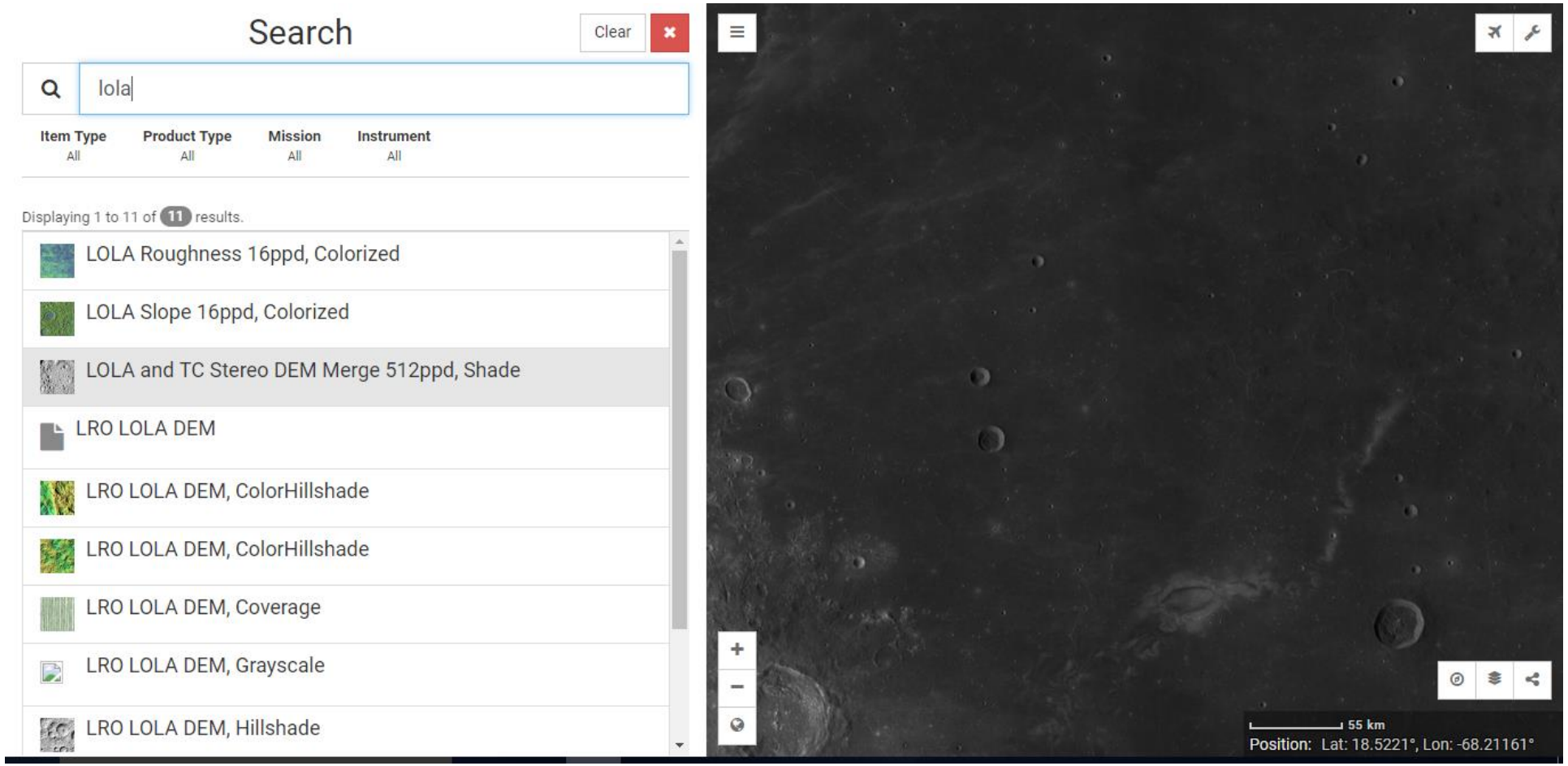
The Marius Hills – one of the most spectacular concentrations of volcanoes on the Moon, as seen by LRO's Wide Angle Camera.

The Marius Hills



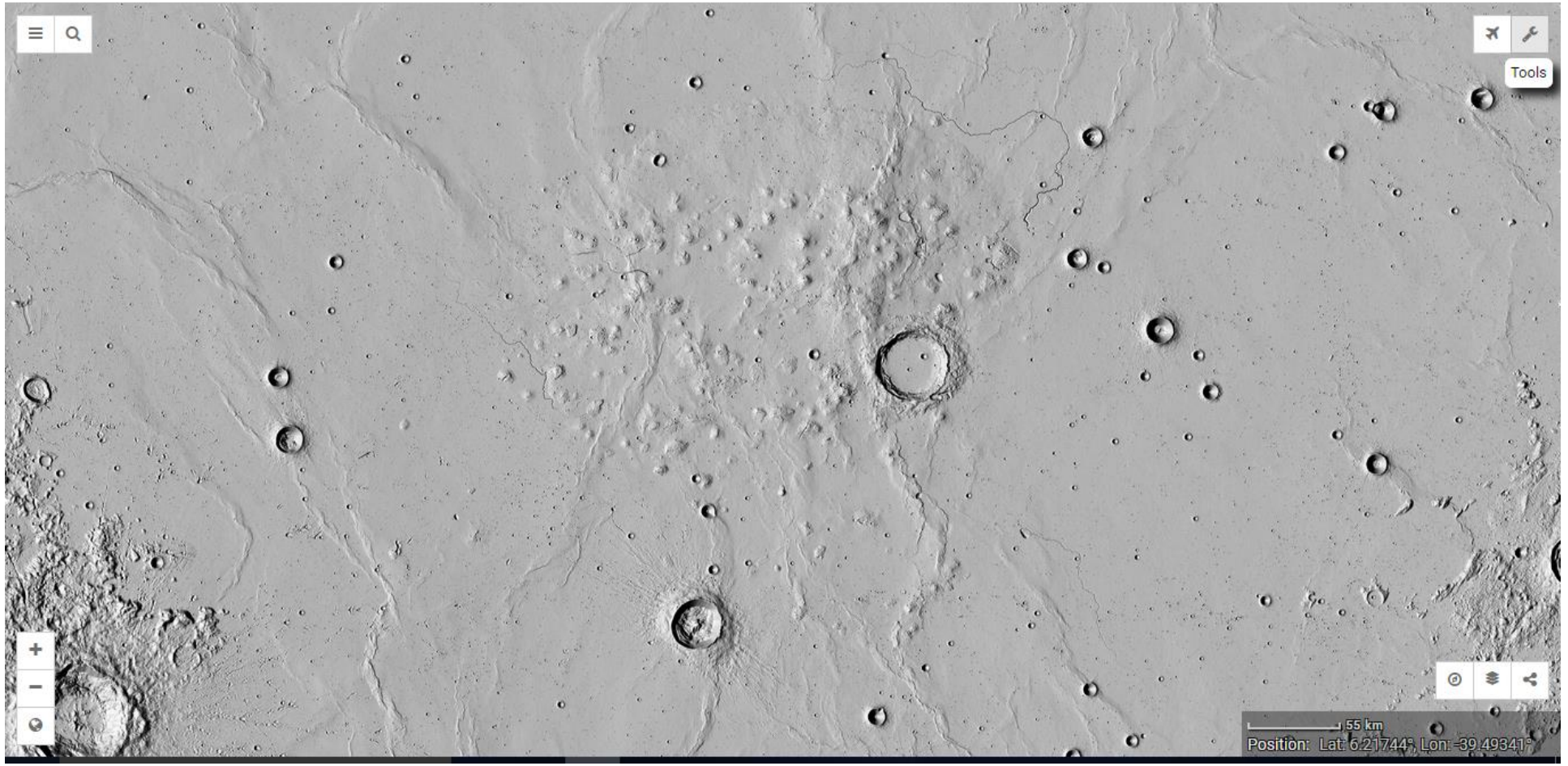
Initially, the Layers Search can be pretty imposing.

The Marius Hills



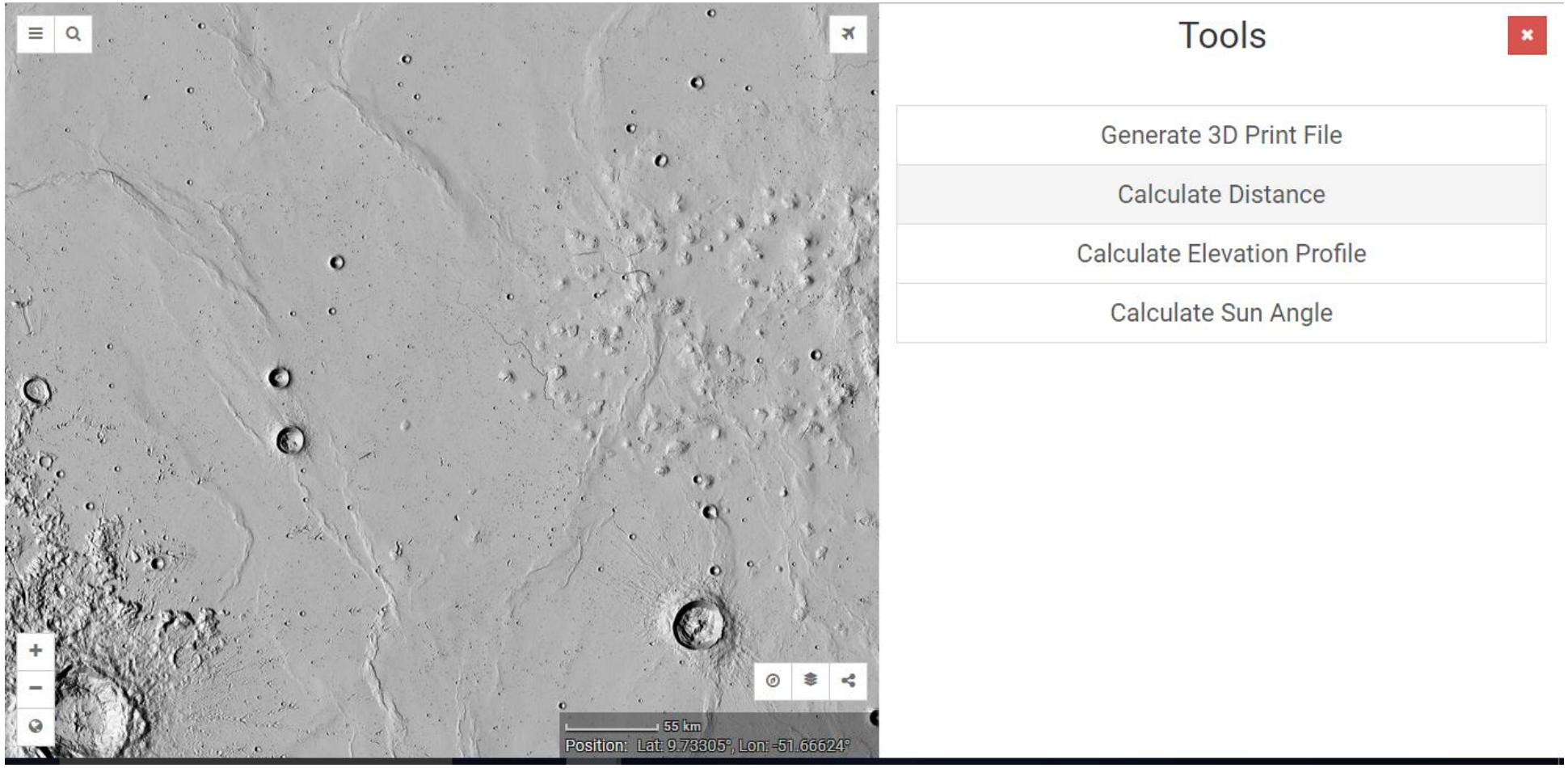
Narrowing the search based on the search term “LOLA”.

The Marius Hills



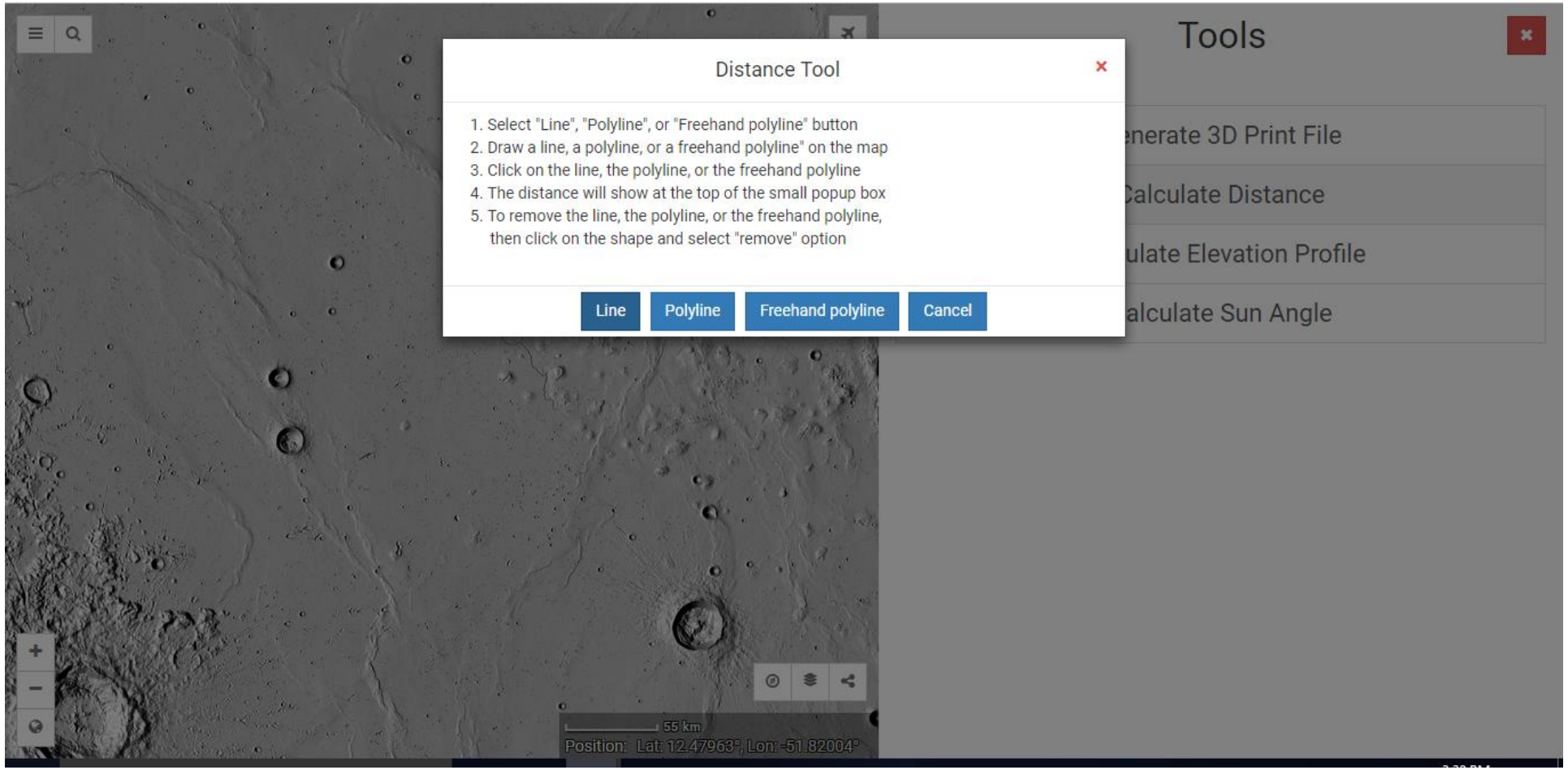
The Marius Hills – one of the most spectacular concentrations of volcanoes on the Moon, as seen using a merge of LRO LOLA and Kaguya TC Stereo.

The Marius Hills



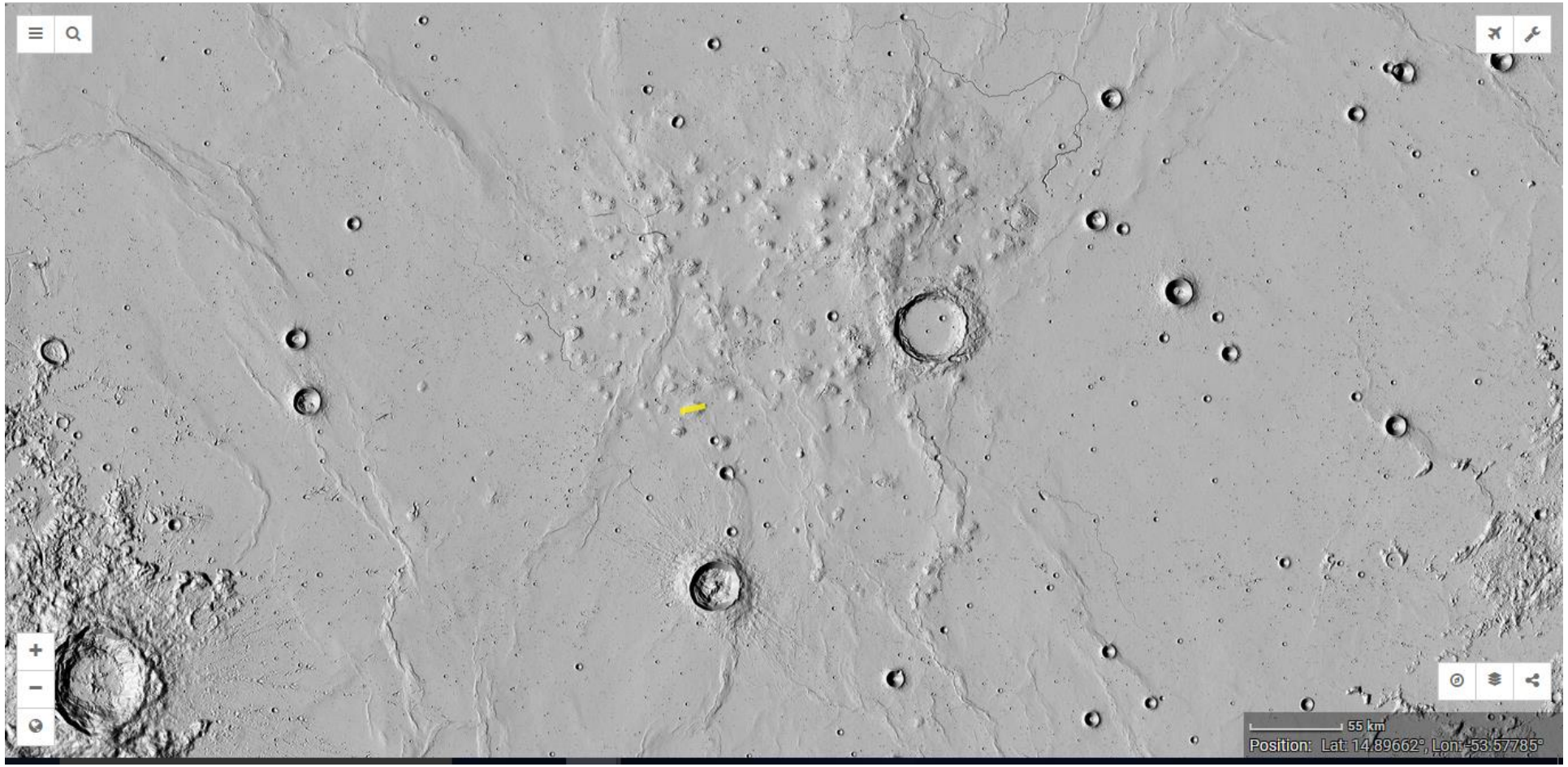
Measure a distance from the basic analysis tools available to any user.

The Marius Hills



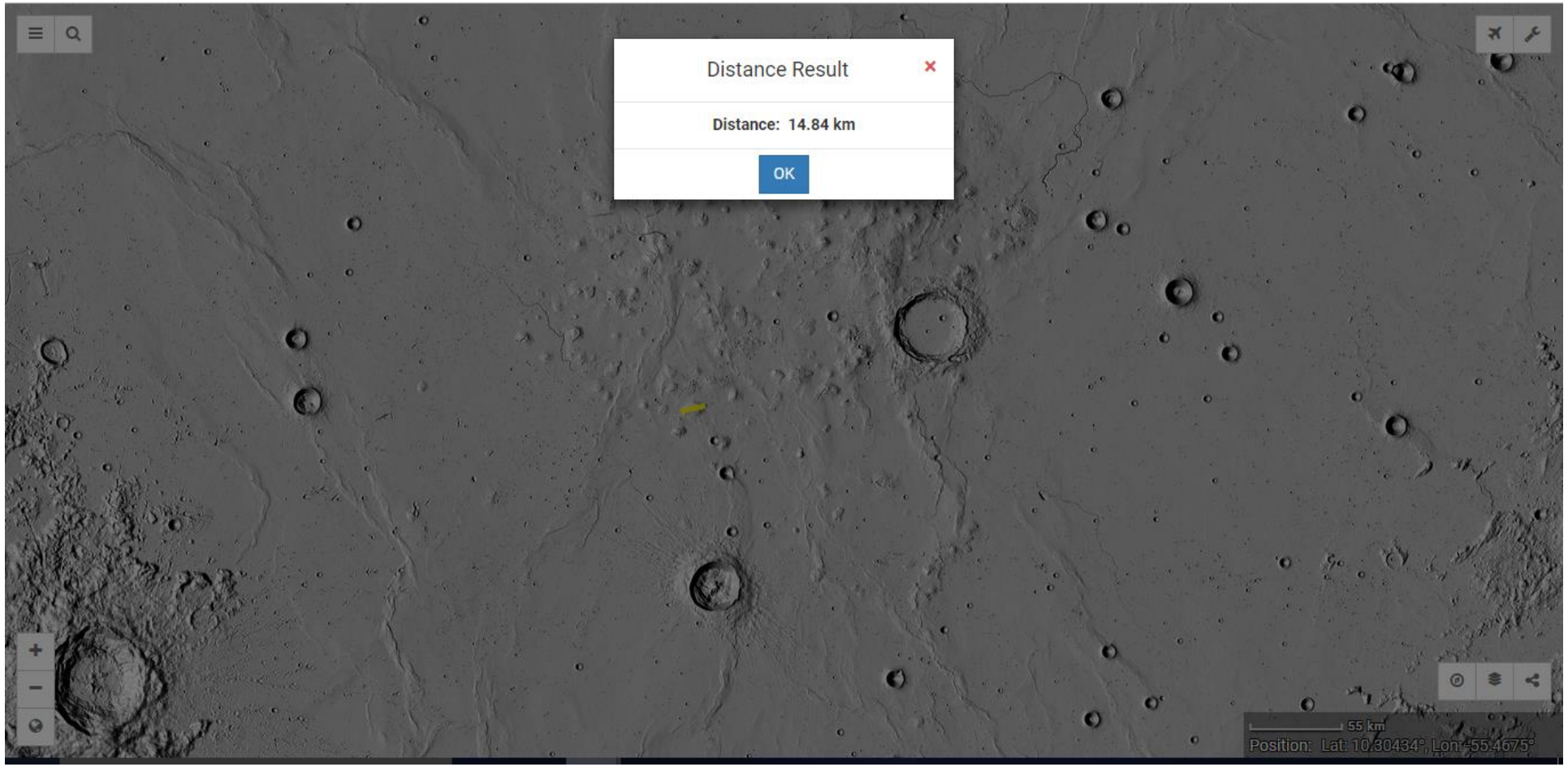
Measure a distance from the basic analysis tools available to any user.

The Marius Hills



Measure a distance from the basic analysis tools available to any user.

The Marius Hills



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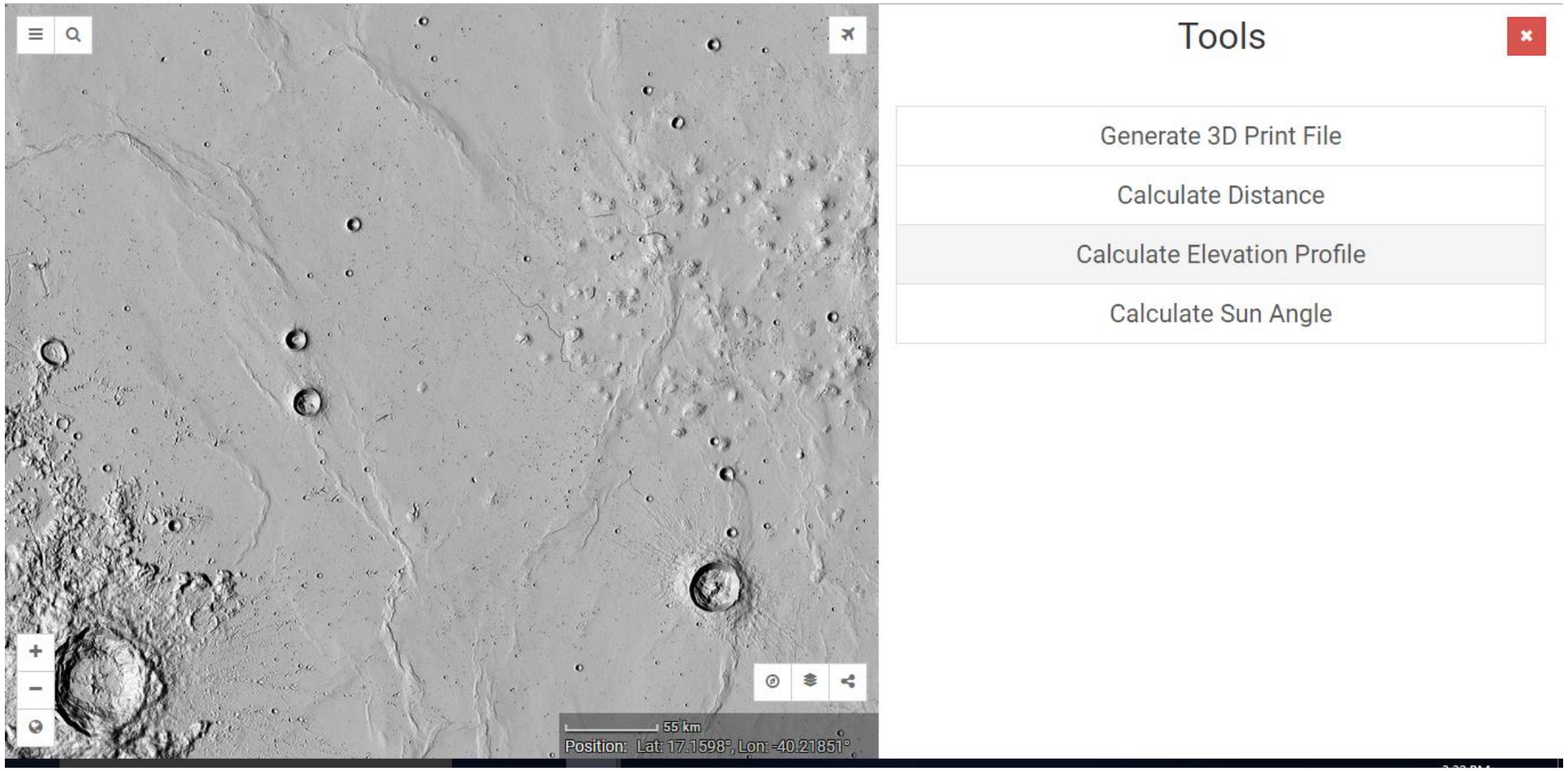
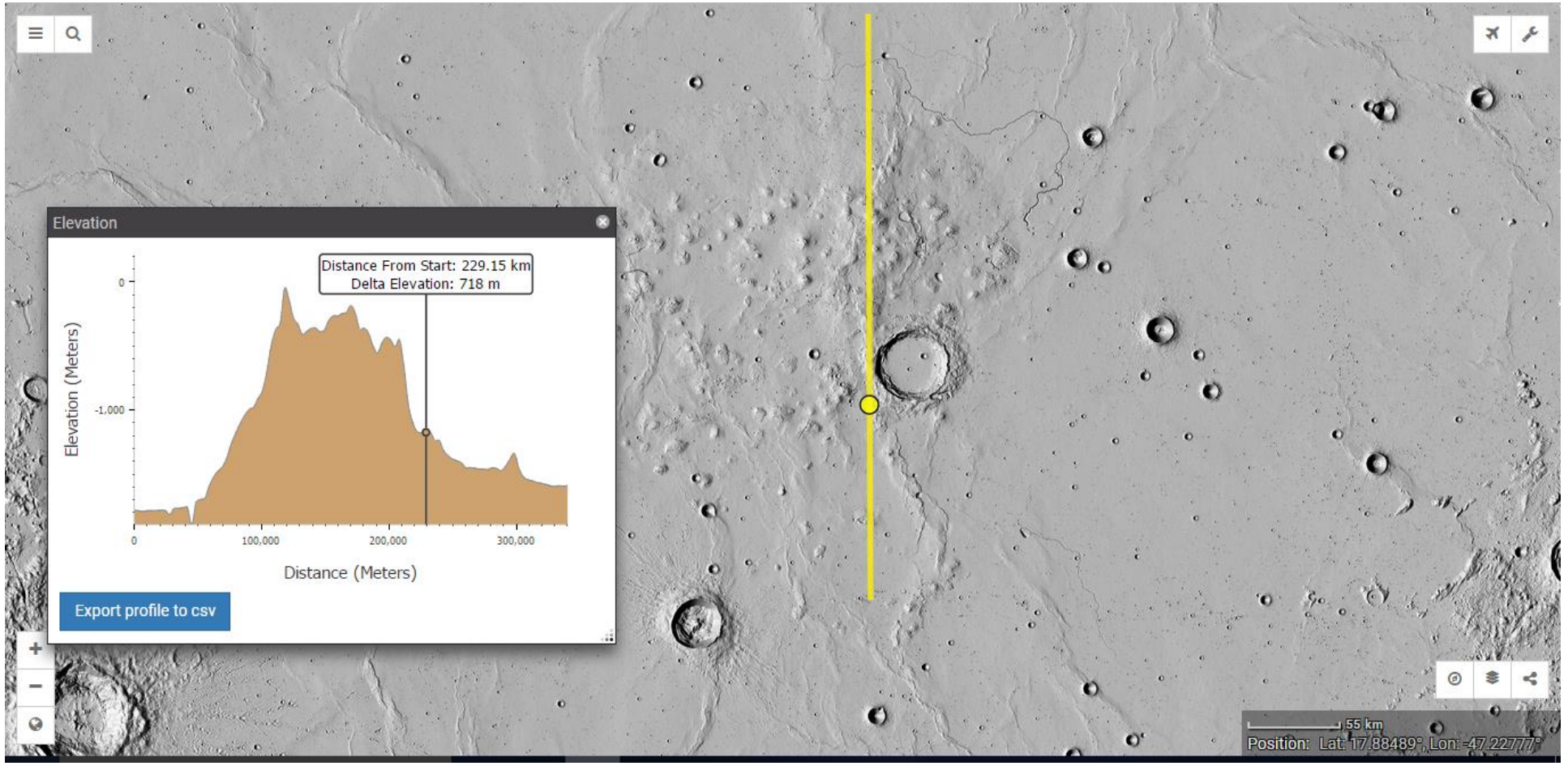
The Marius Hills



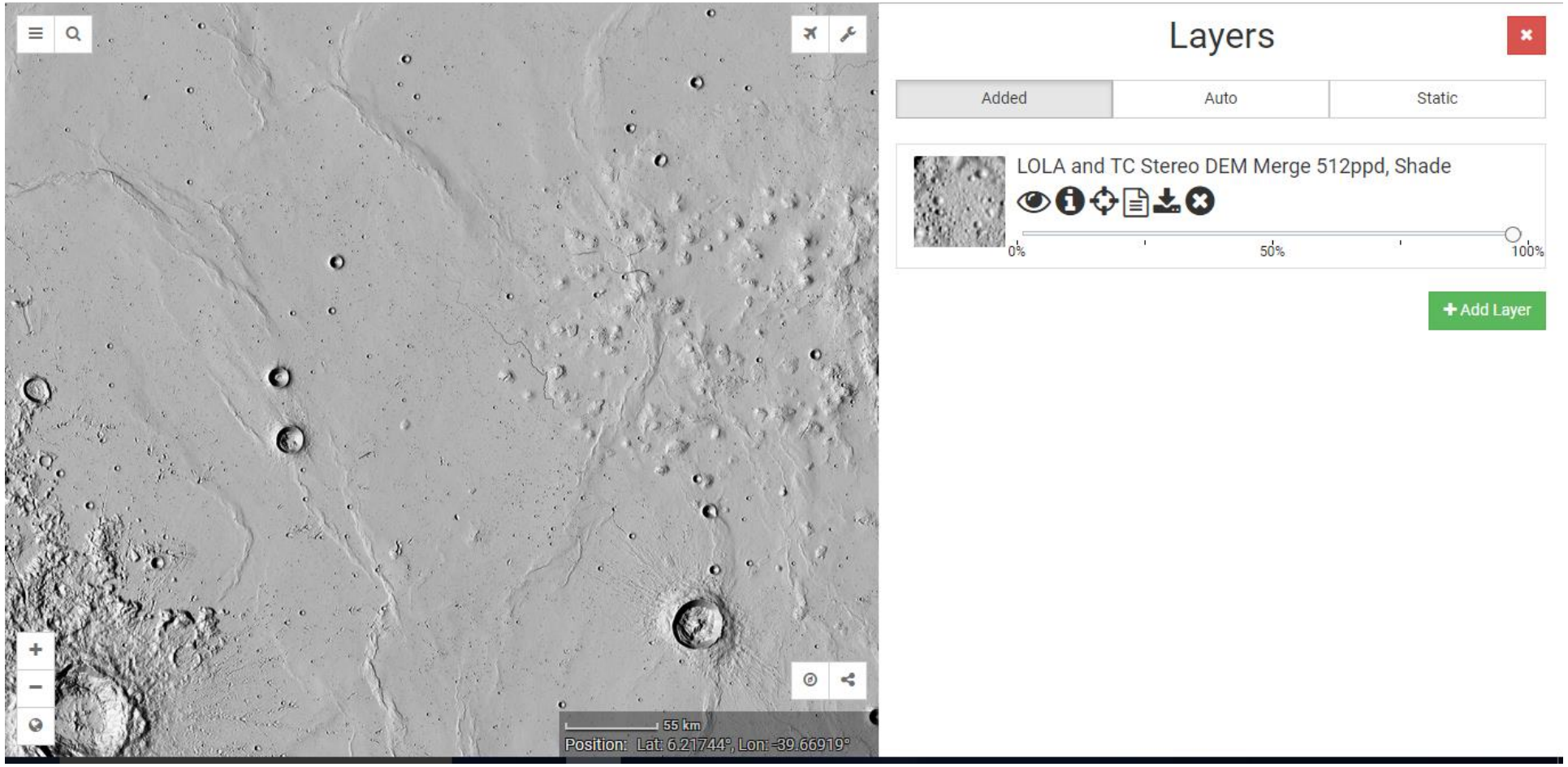
Calculate an elevation profile from the basic analysis tools available to any user.

The Marius Hills



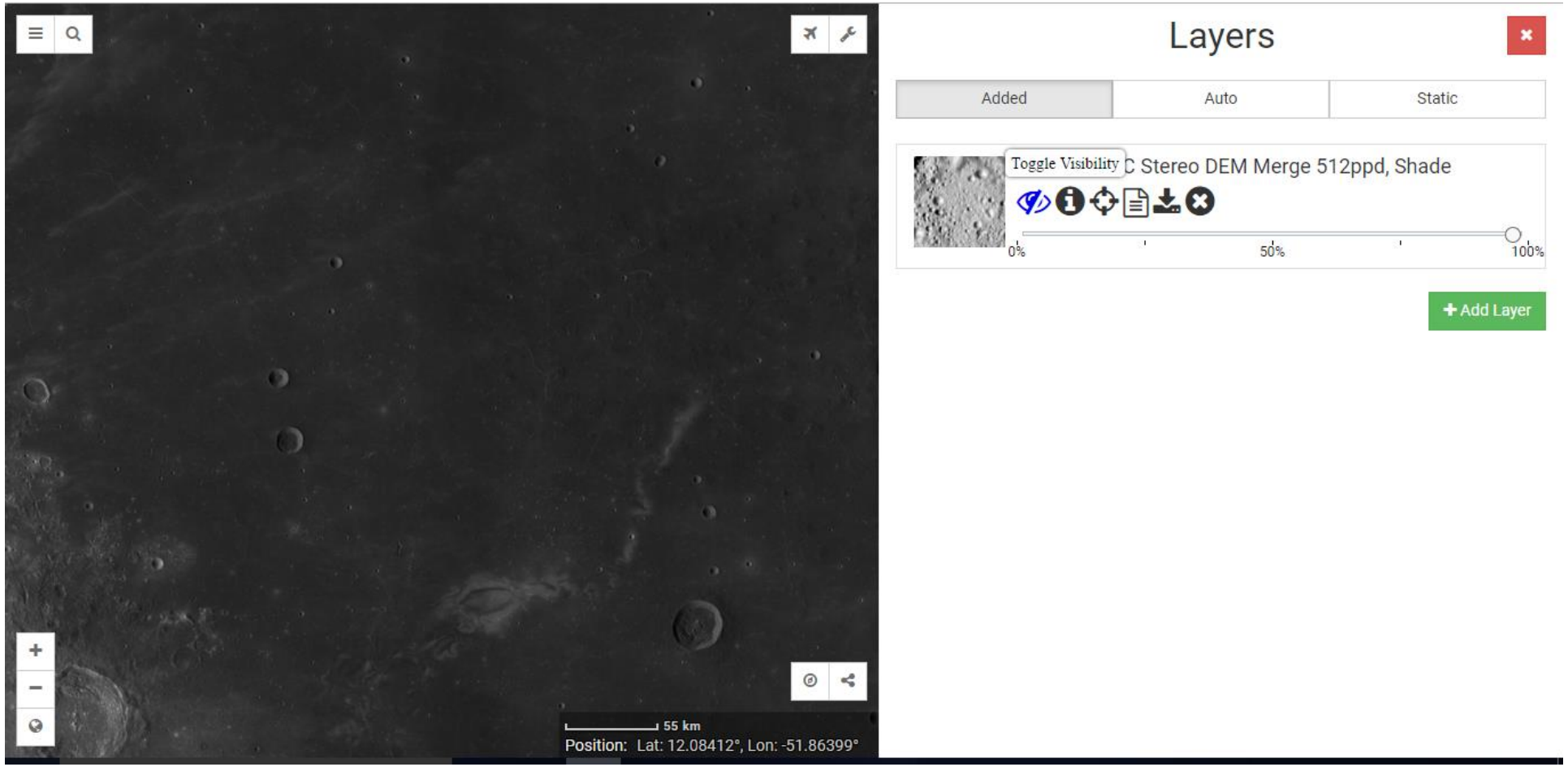
Calculate an elevation profile from the basic analysis tools available to any user.

The Marius Hills



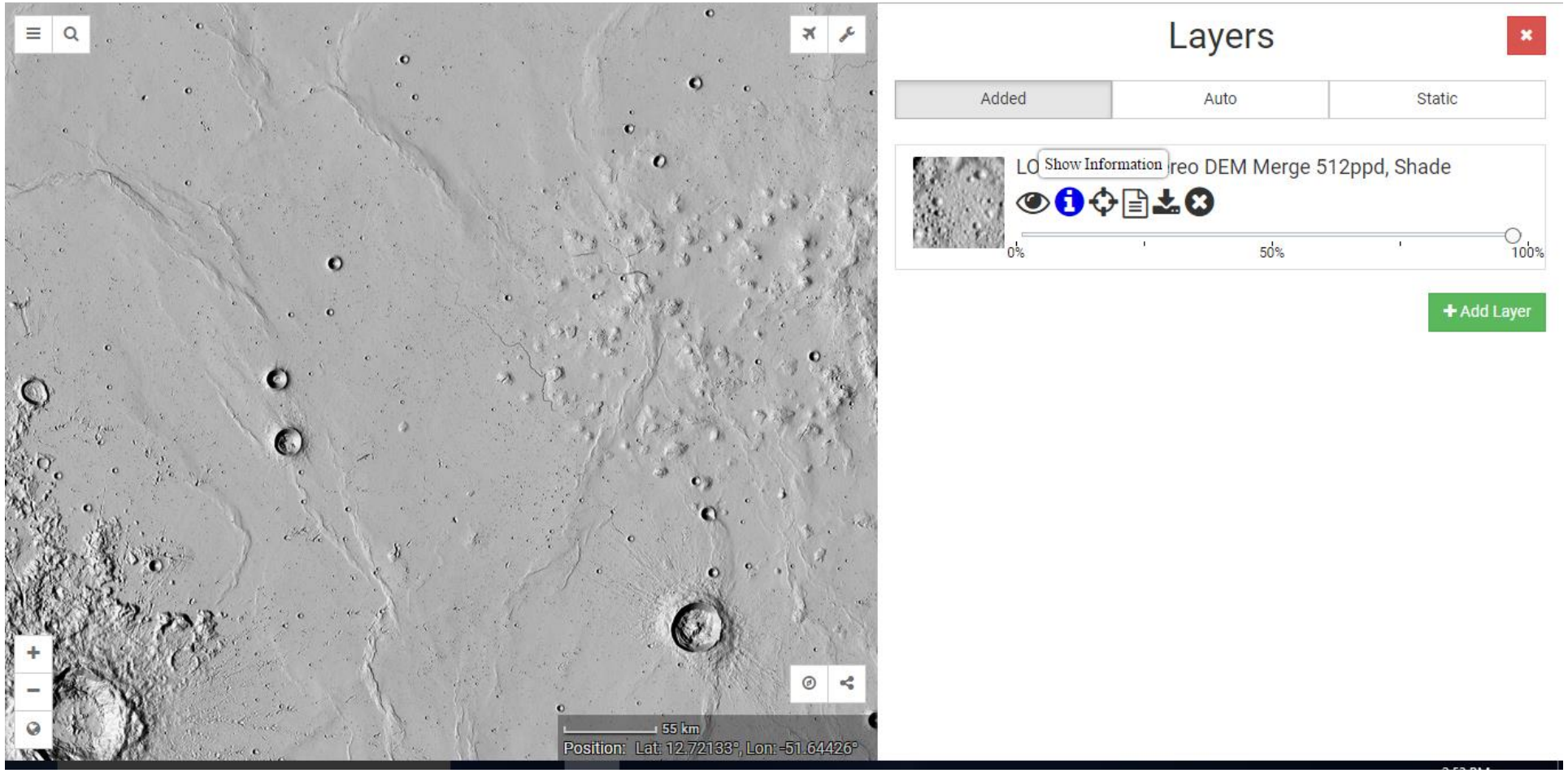
Functions associated with layers that have been loaded.

The Marius Hills



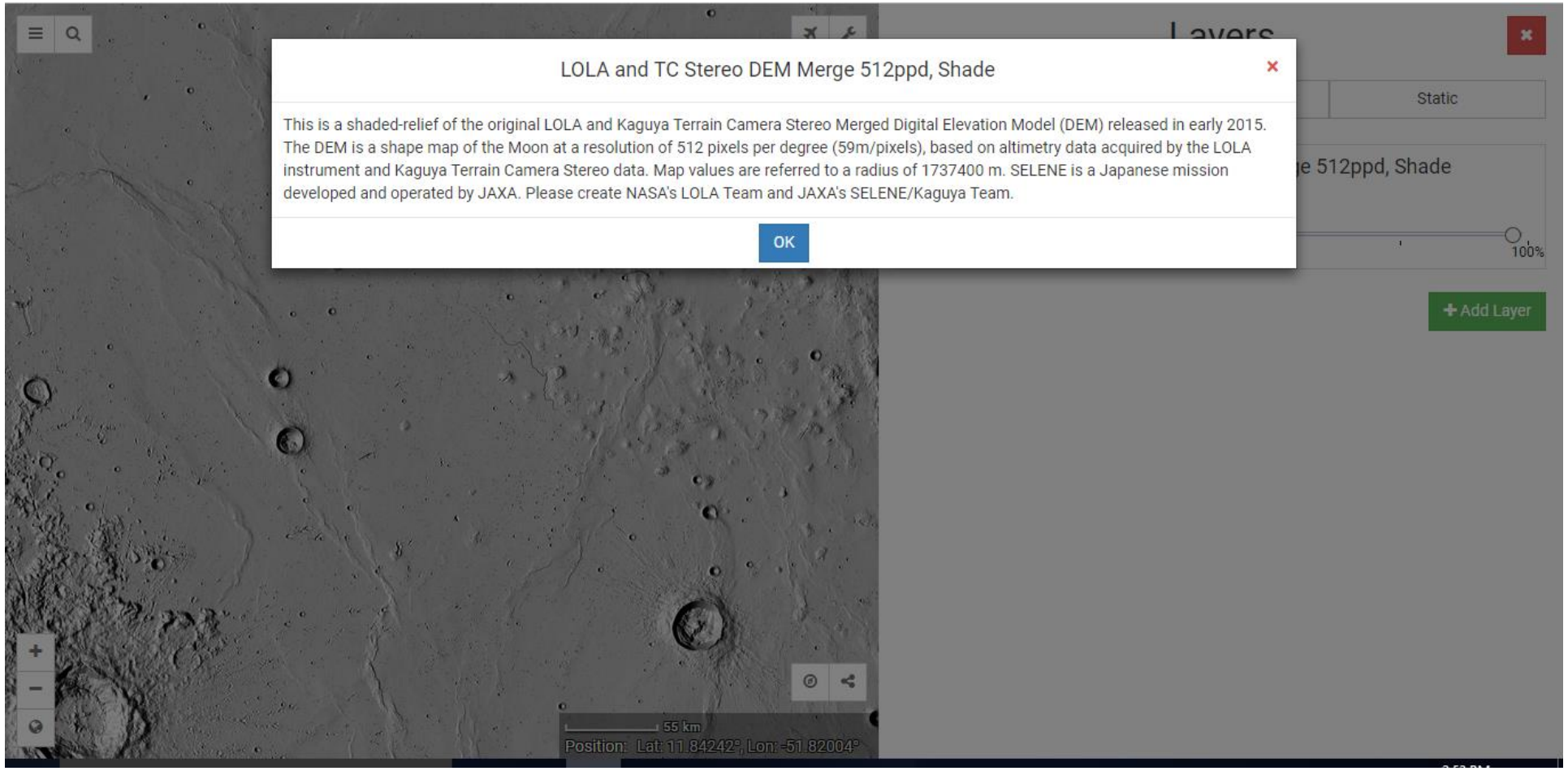
Toggle visibility

The Marius Hills



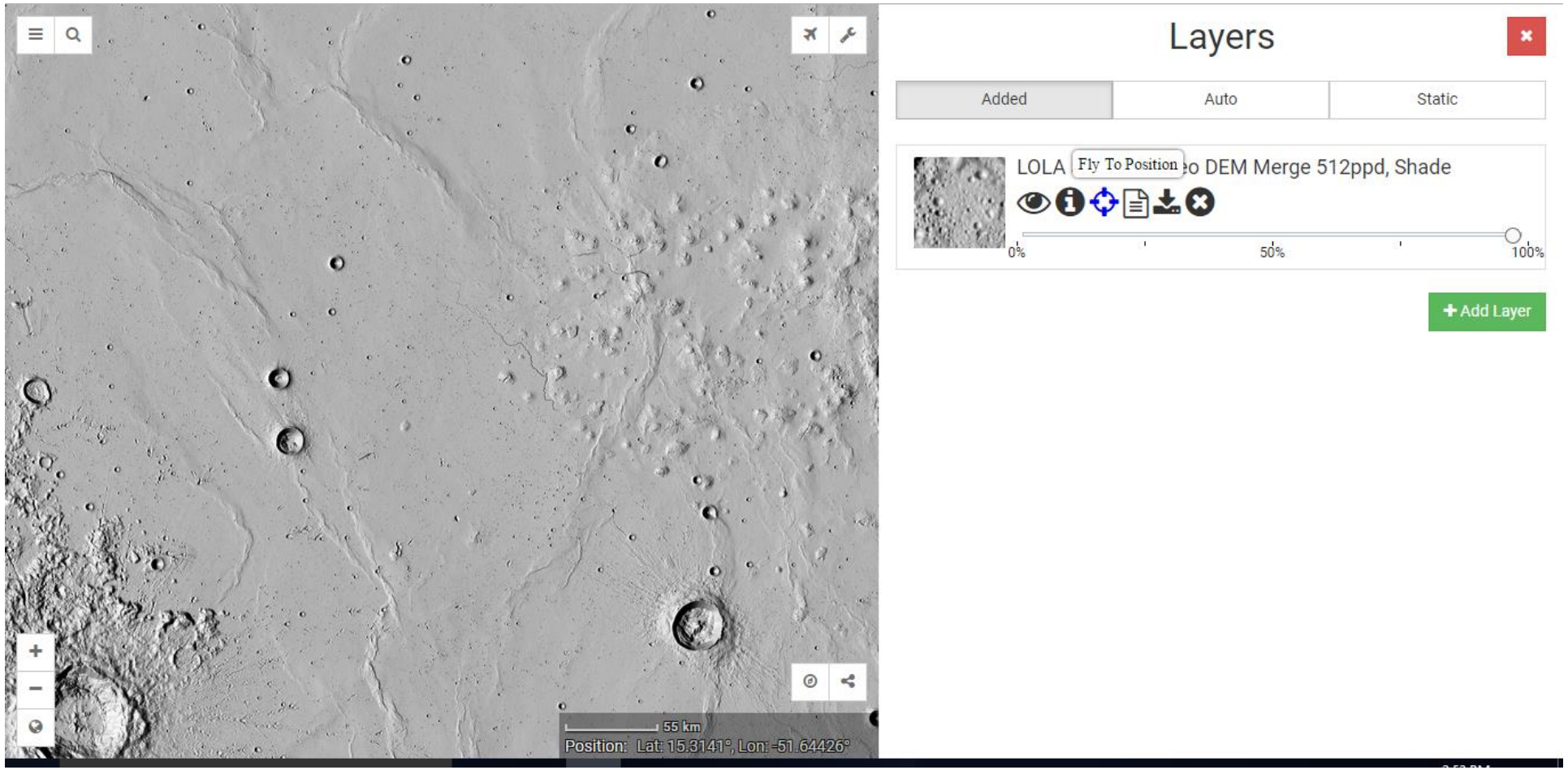
View general information about the layer.

The Marius Hills



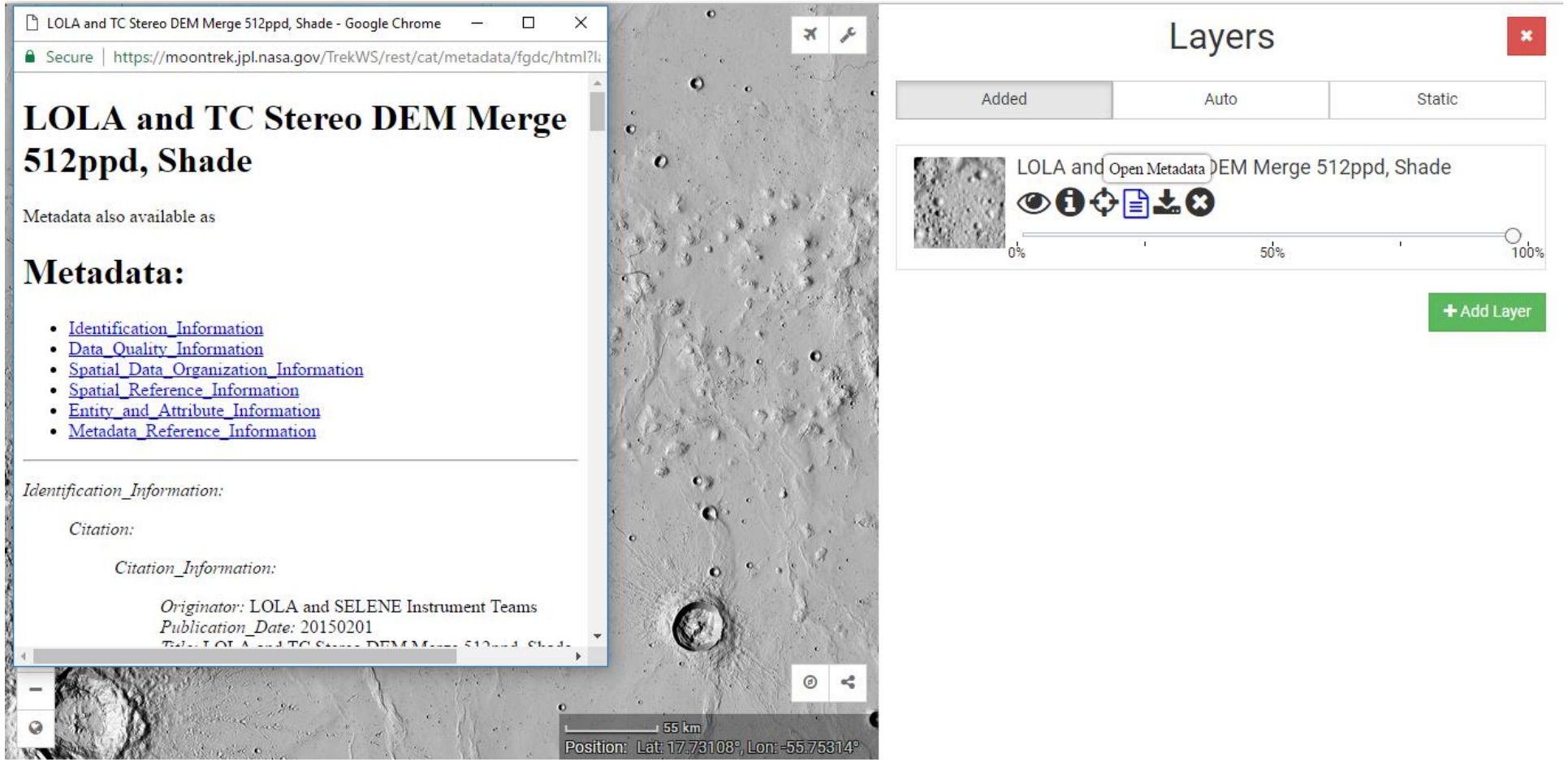
View general information about the layer.

The Marius Hills



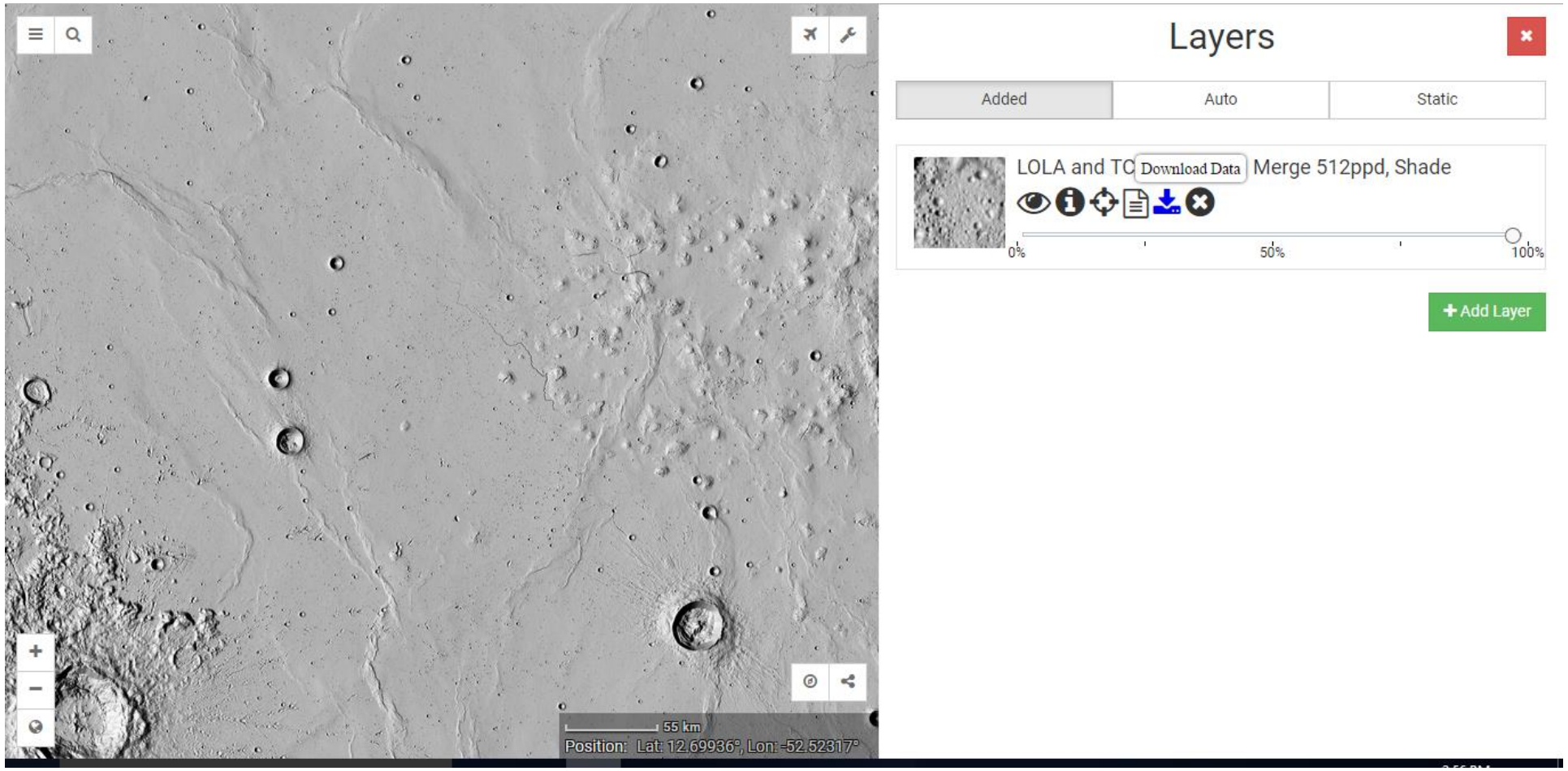
Fly to position.

The Marius Hills



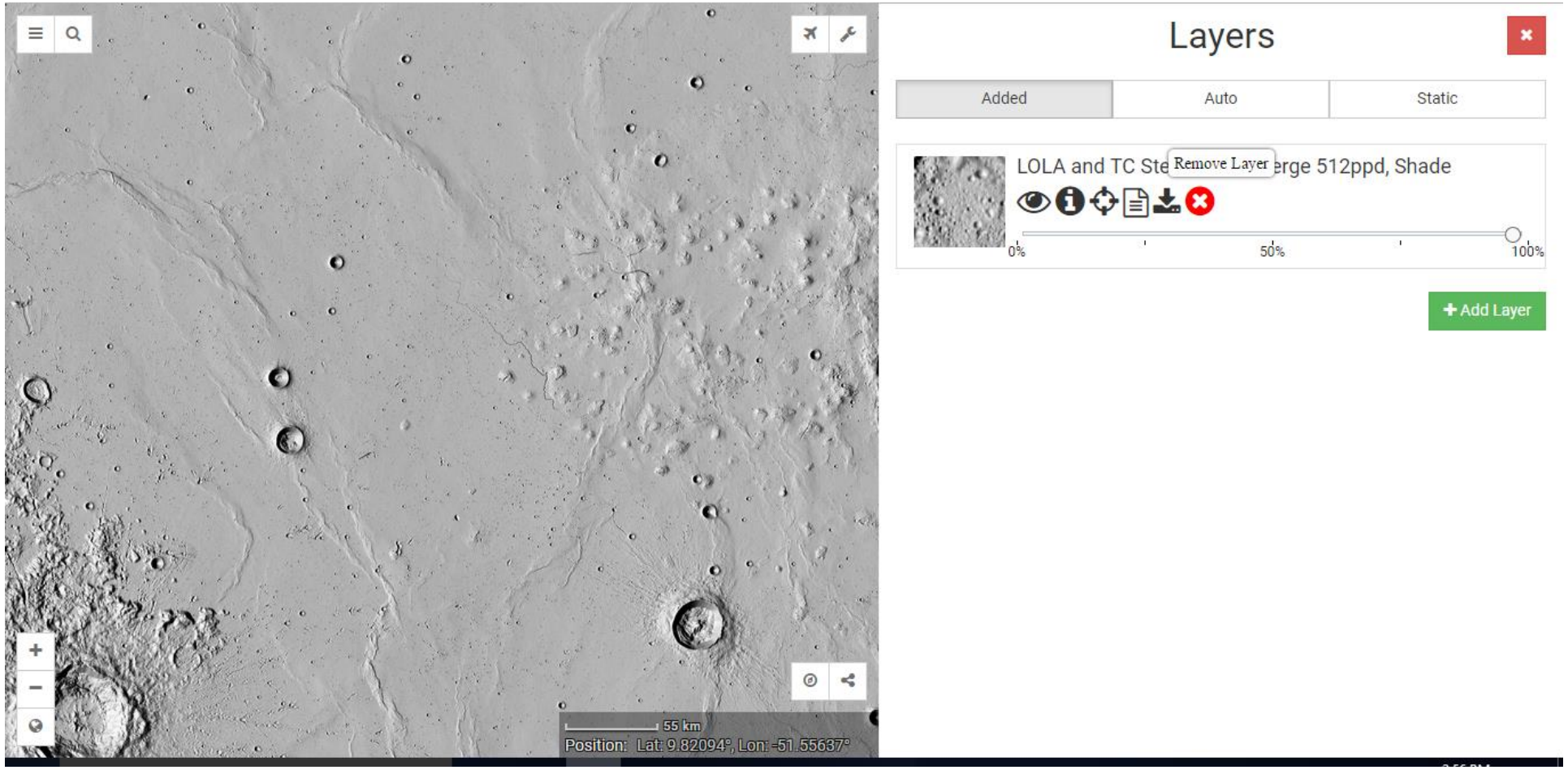
View metadata.

The Marius Hills



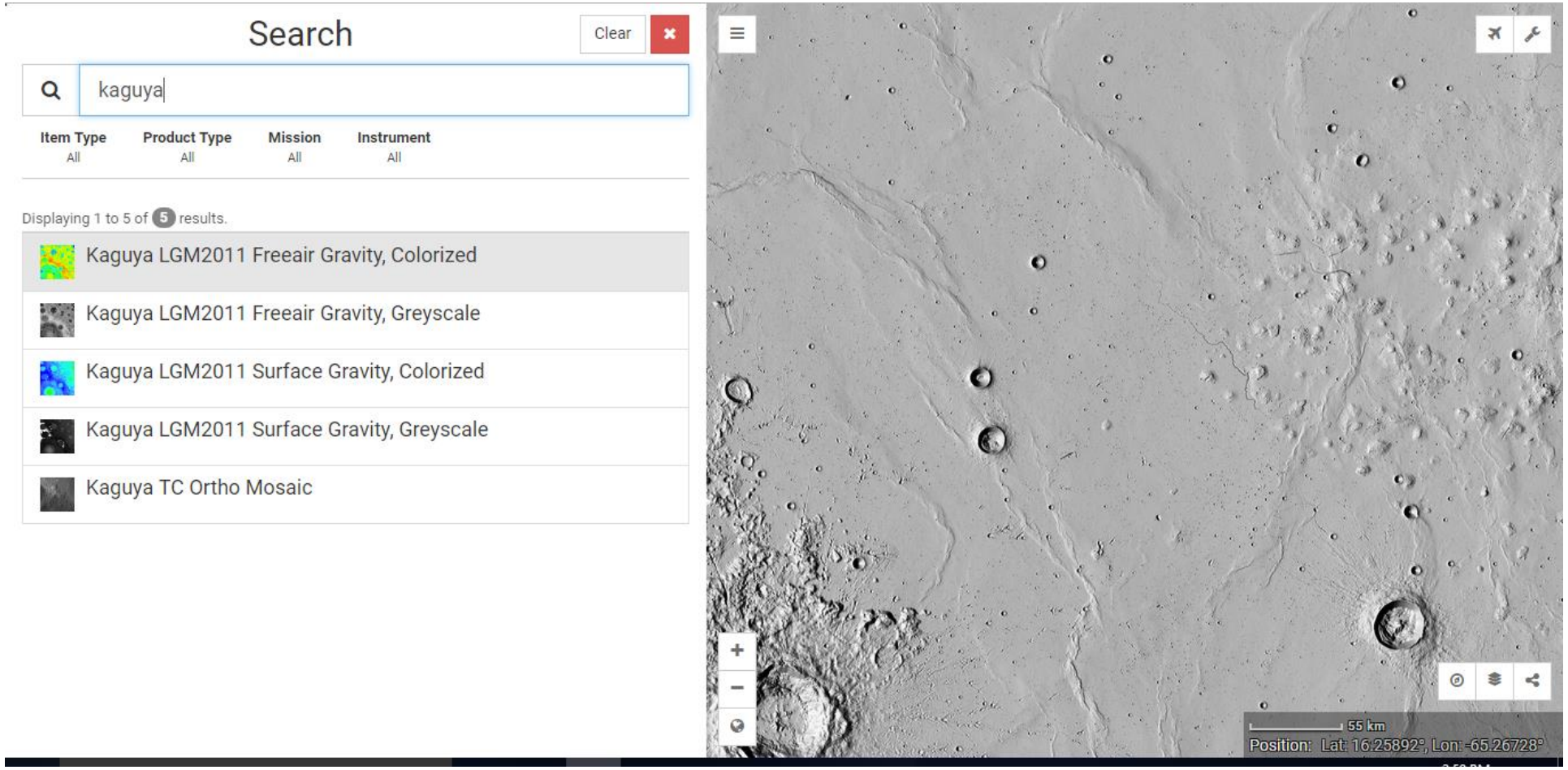
Download data.

The Marius Hills



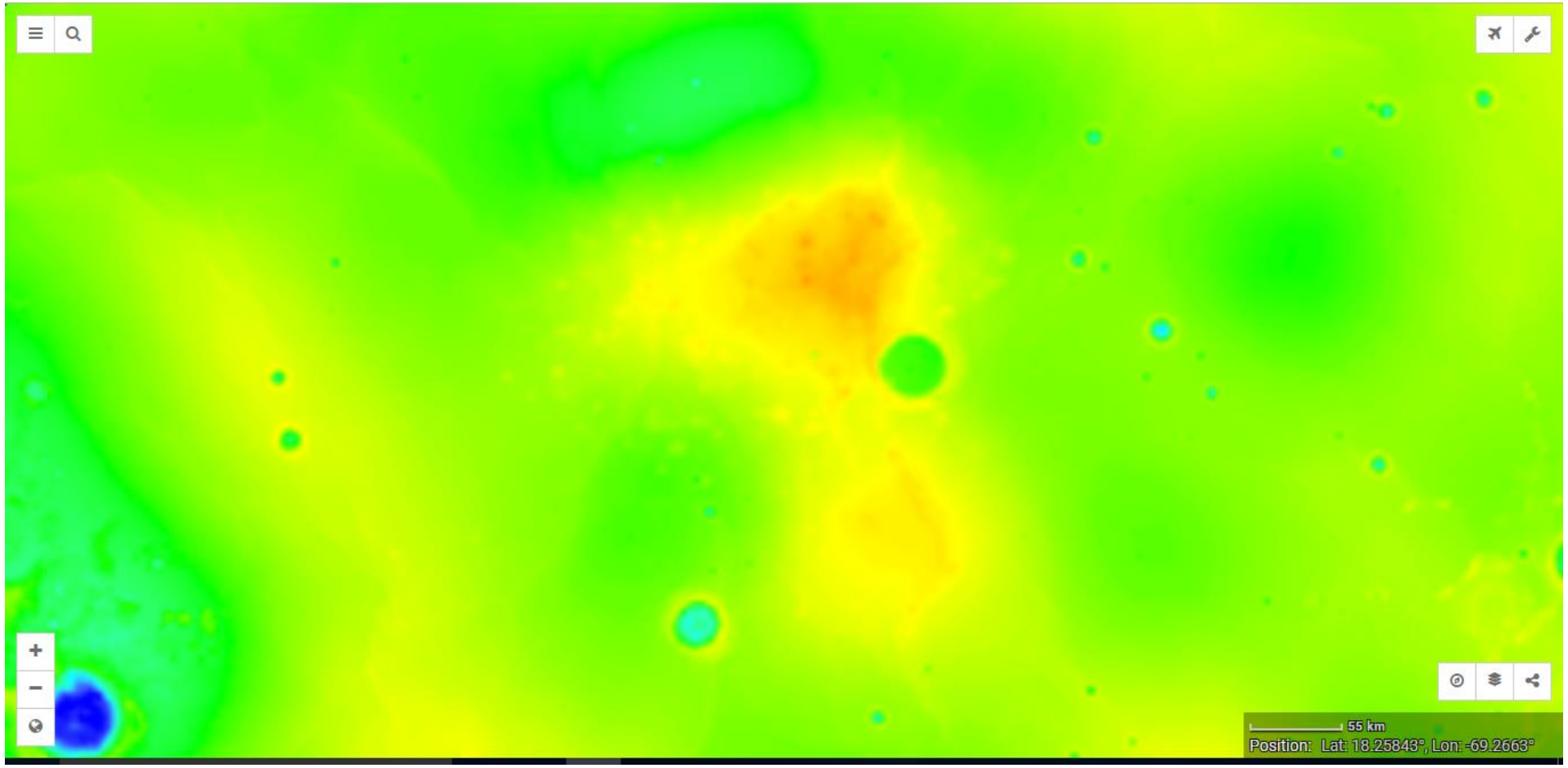
Remove the layer from your stack of loaded layers.

The Marius Hills



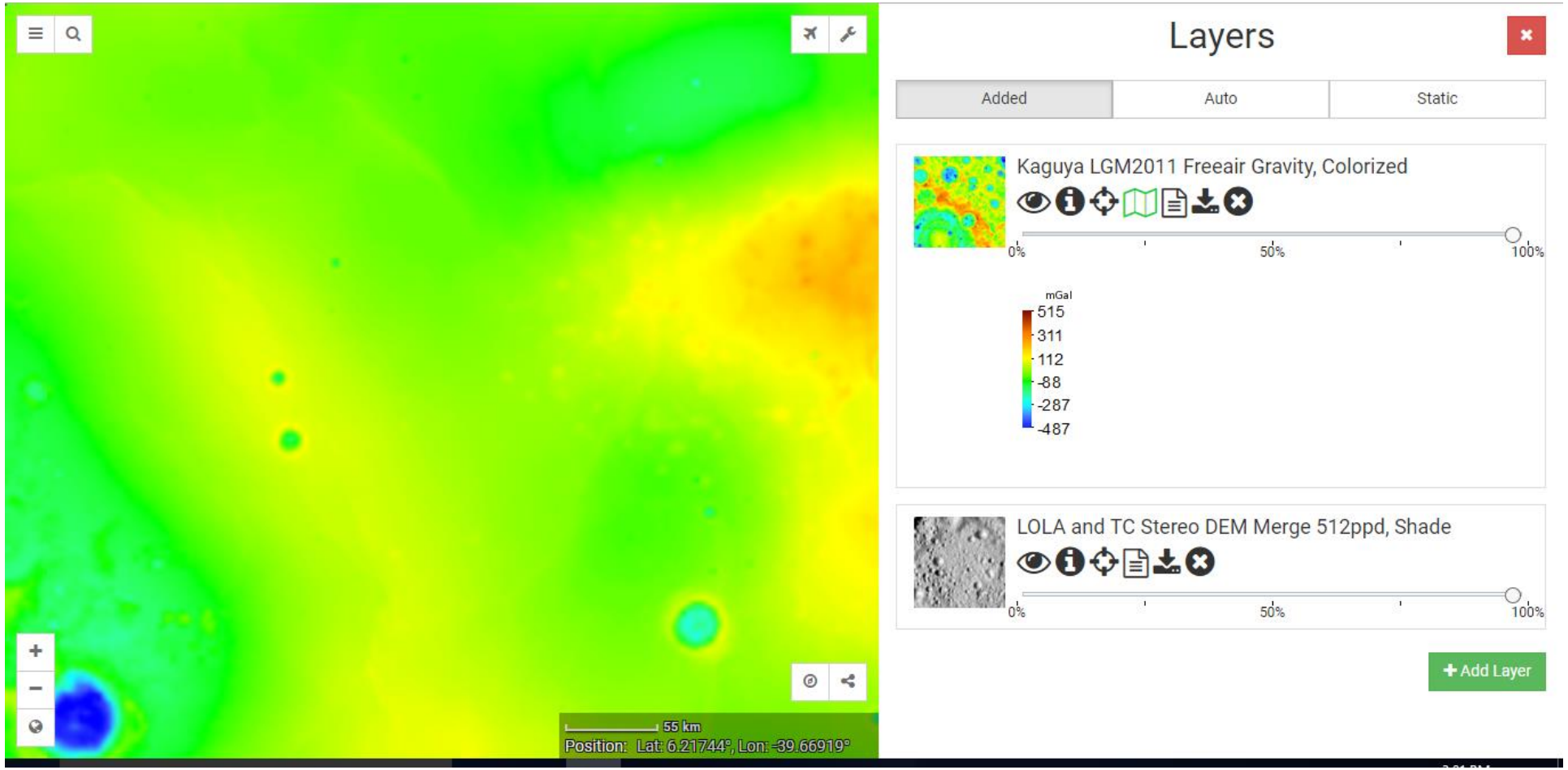
Search for “Kaguya” layers and load the Colorized Freeair Gravity Map.

The Marius Hills



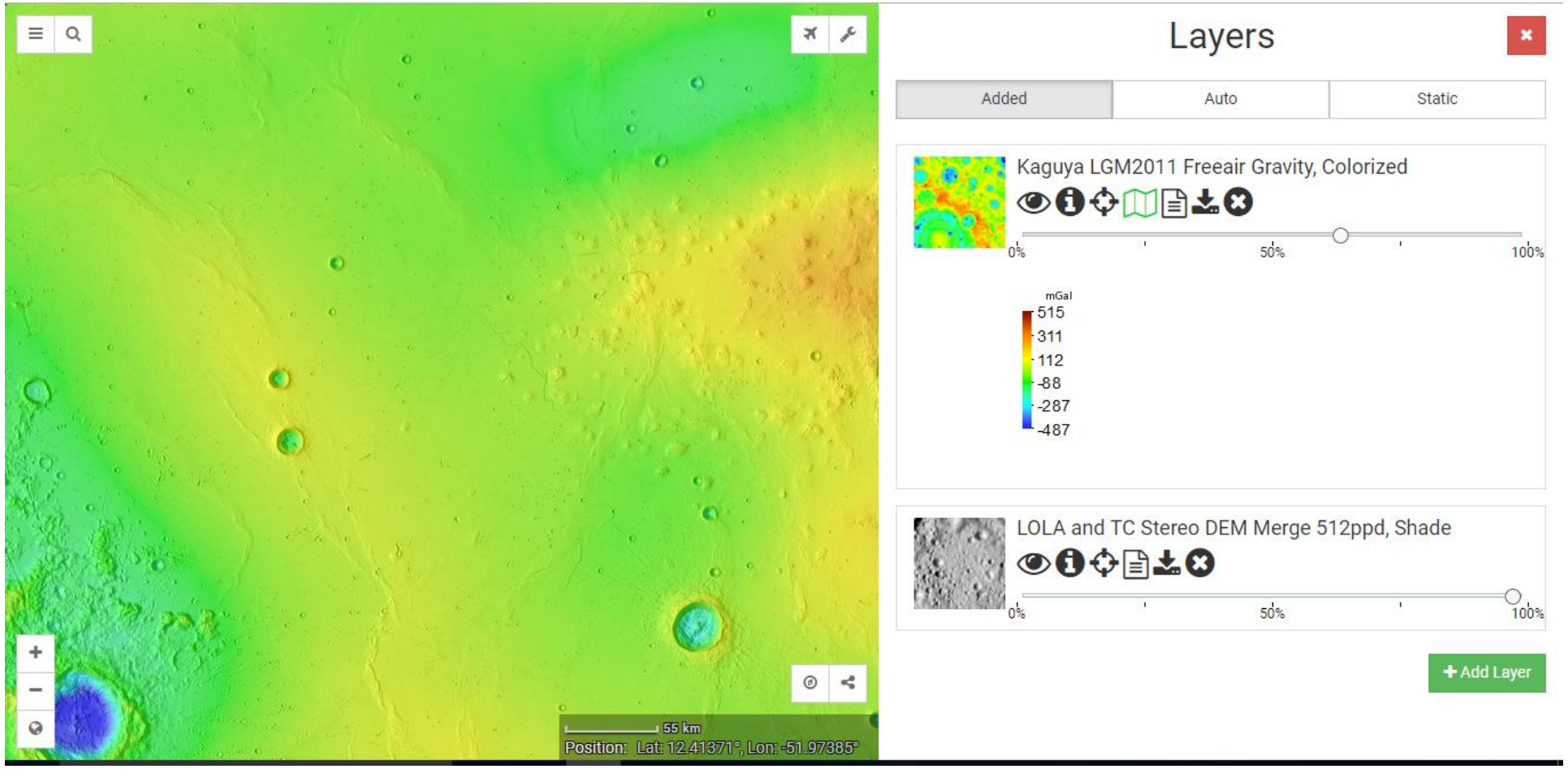
Kaguya Colorized Freeair Gravity Map of the same area.

The Marius Hills



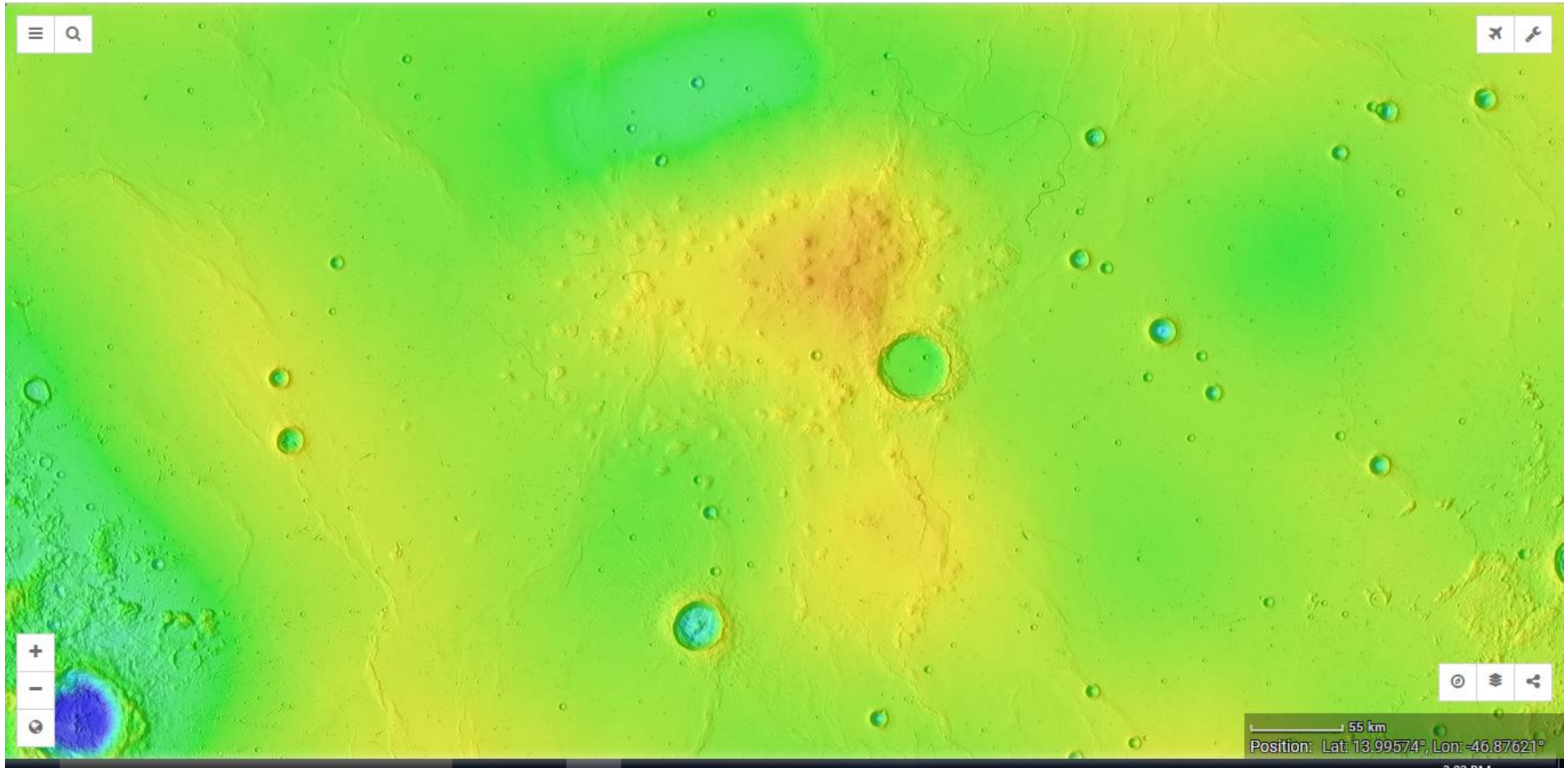
Show the legend for this layer

The Marius Hills



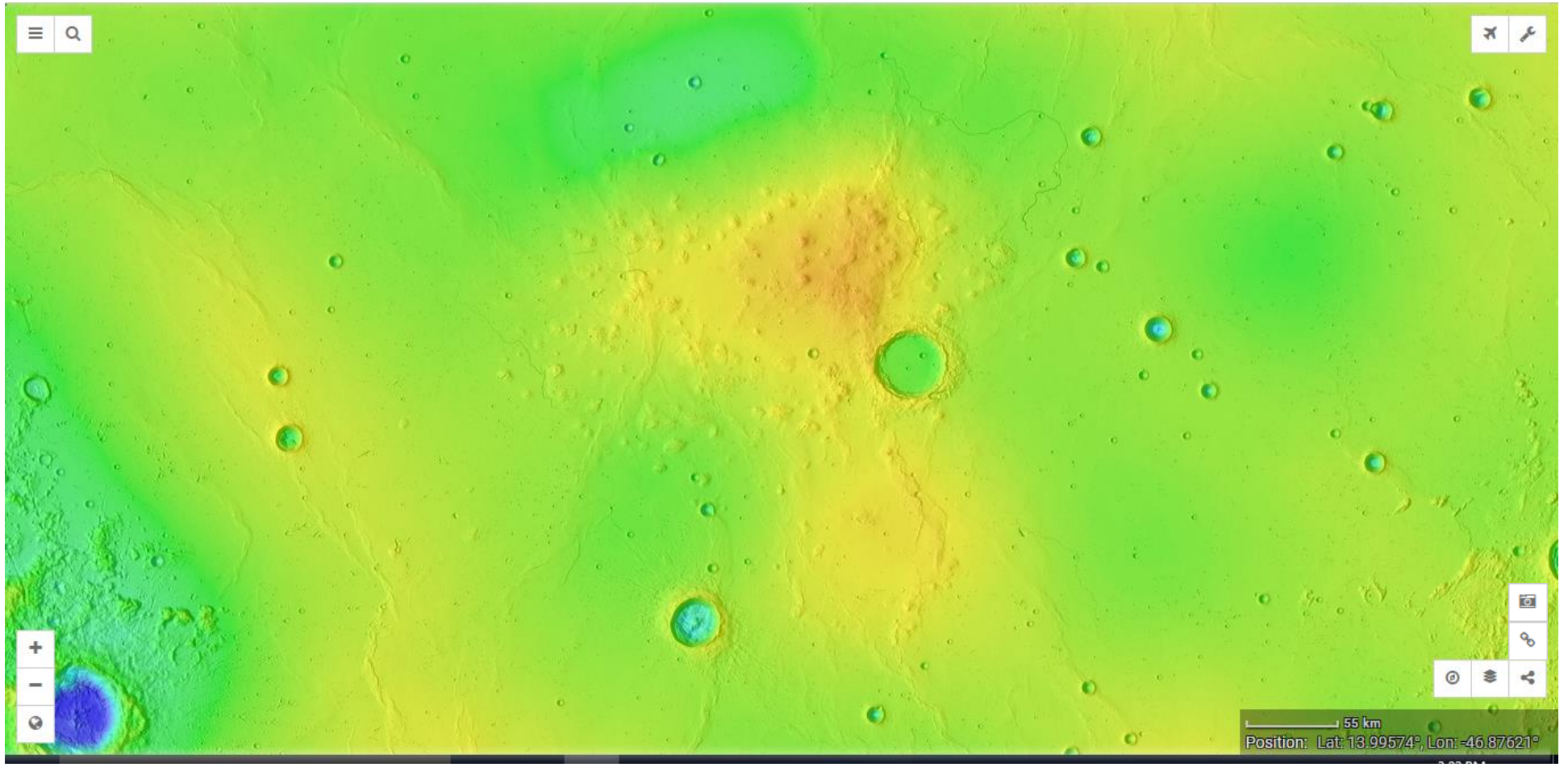
Adjust transparency of top gravity map layer to blend in the topography shown in the next layer down.

The Marius Hills



This allows us to visualize the surface topography of the volcanic field as well as the now-solidified, unerupted magma chamber beneath the complex.

The Marius Hills



Share your visualization by either generating a screen capture or a URL web link.

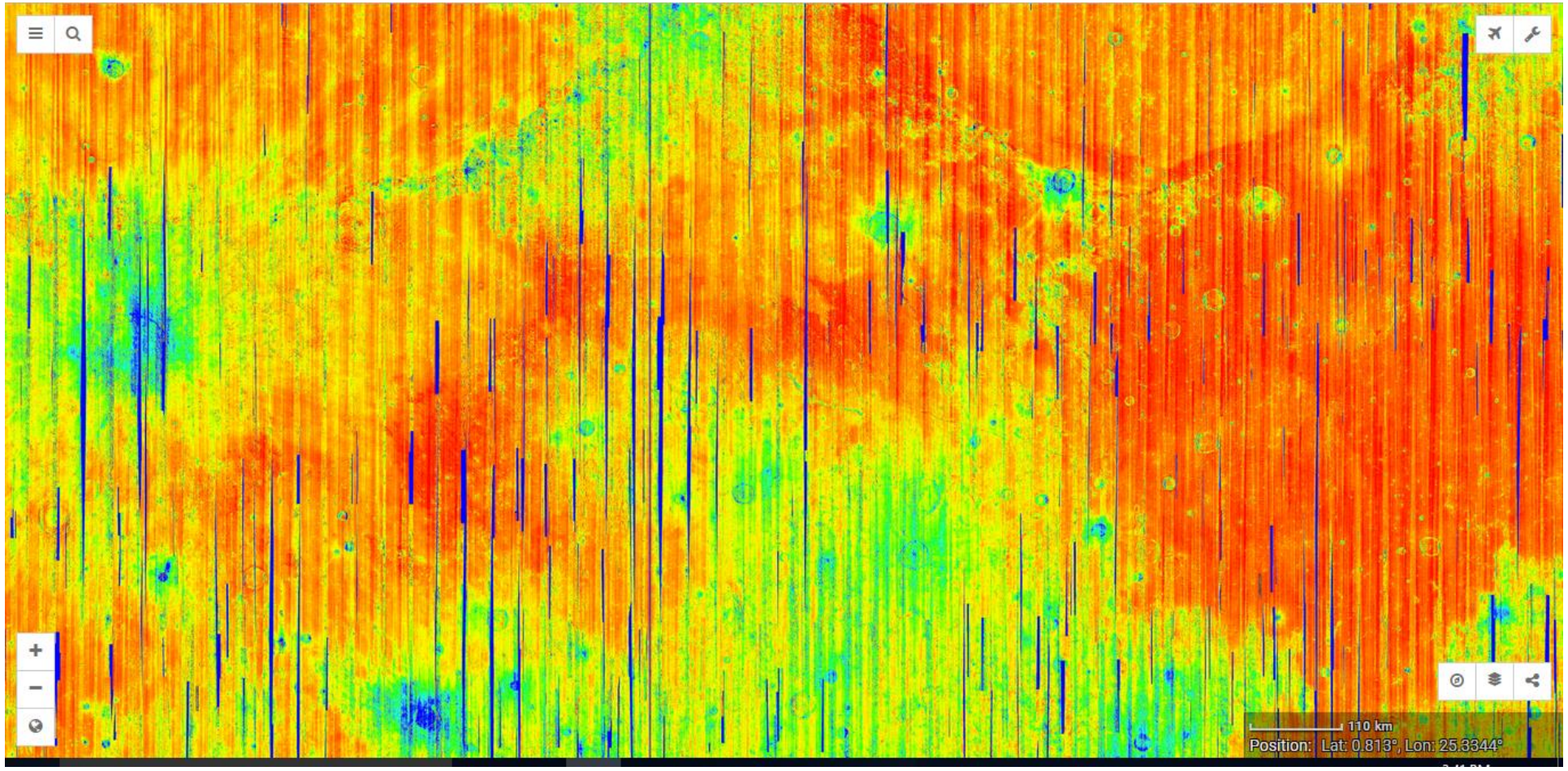
Mineralogy

- Where's Moon Mineralogy Mapper?
  - Star tracker problem resulted in georeferencing errors for the product.
  - Efforts to correct the product are underway.
  - We will integrate once a corrected product is available.
- Do have a variety of Clementine and Lunar Prospector products now.
- Working with Myriam Lemelin (SSERVI CLSE) to integrate strong signal and well-calibrated reflectance acquired by two different instruments, the Kaguya Spectra Profiler (SP) and the Lunar Orbiter Laser Altimeter (LOLA), in order to derive the first FeO and mineral maps of the polar regions at a spatial resolution of 1 km per pixel.
- Working to integrate Paul Lucey's combined visible and near-IR multispectral data from the Kaguya Multiband Imager (MI) with thermal infrared multispectral data from the LRO Diviner Lunar Radiometer Experiment to produce global mineral abundance data at 60-m resolution.
- Planning to integrate Ice Stability depth maps by SSERVI researcher Matt Siegler (PSI).

A few more layer examples

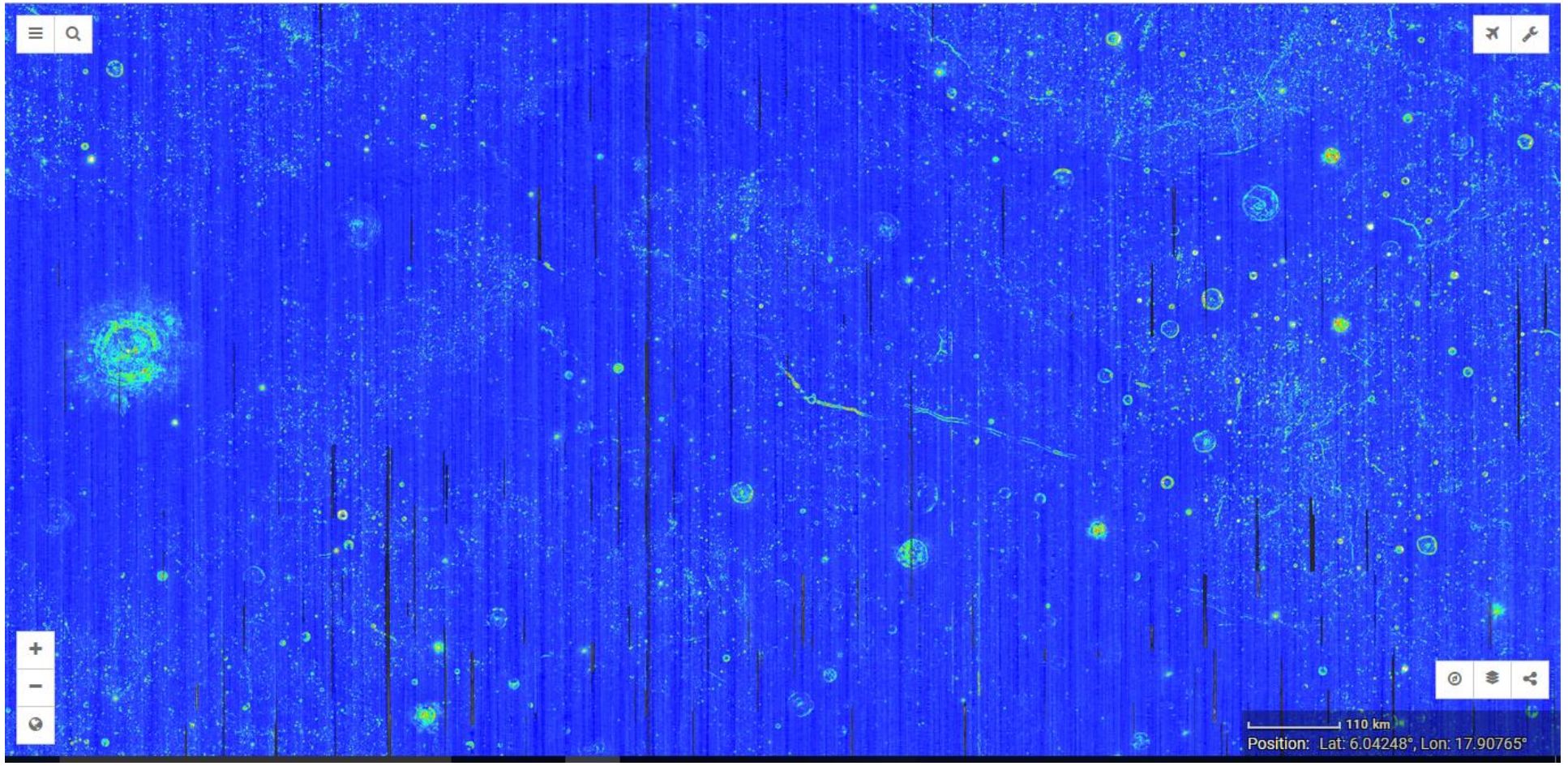
WAC mosaic of Sinus Medii area.

A few more layer examples



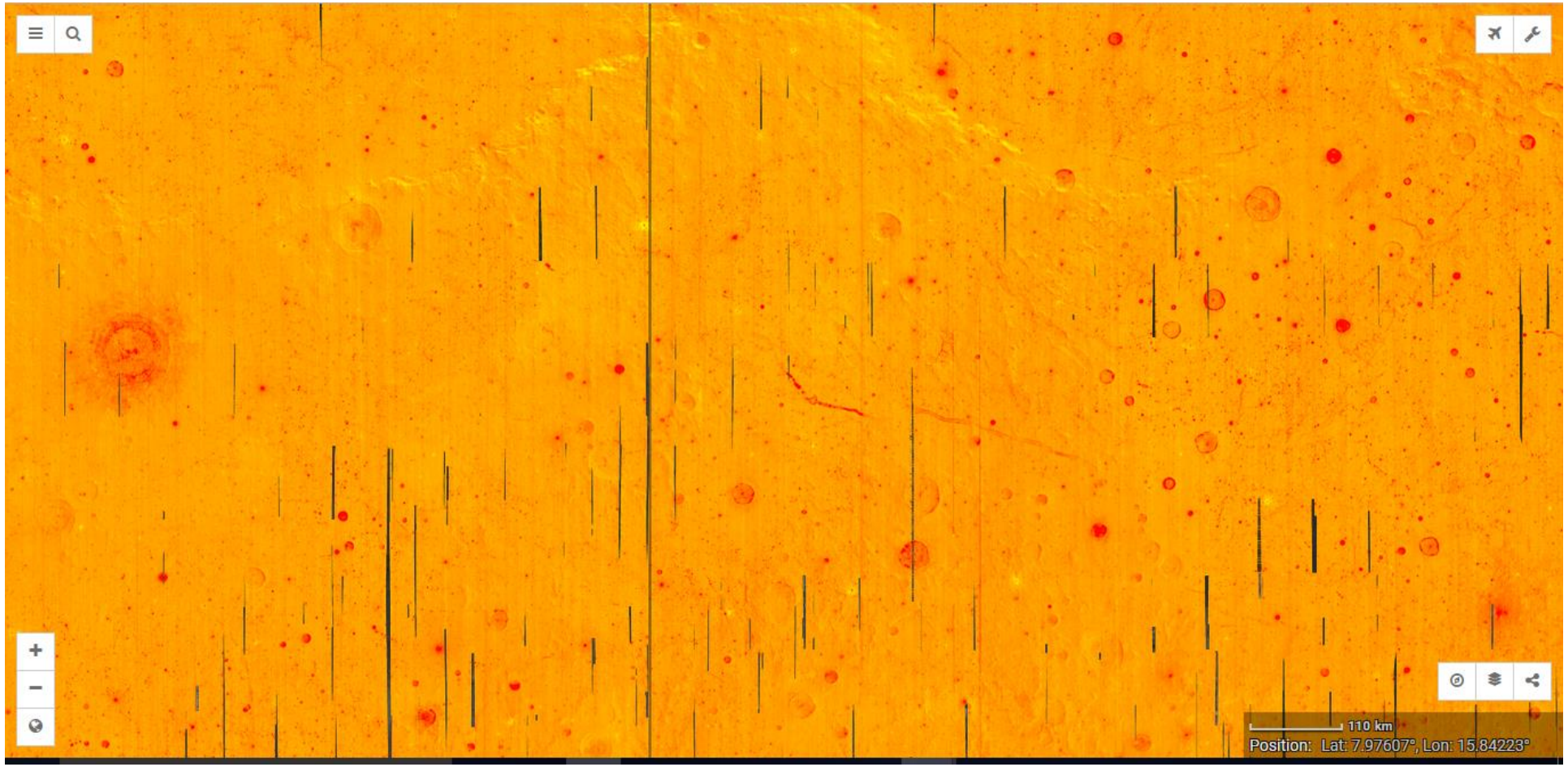
Same area, LRO DIVINER CF Mosaic 128ppd, Colorized

A few more layer examples



Same area, LRO Diviner Rock Abundance Mosaic 128ppd, Colorized

WAC Mosaic



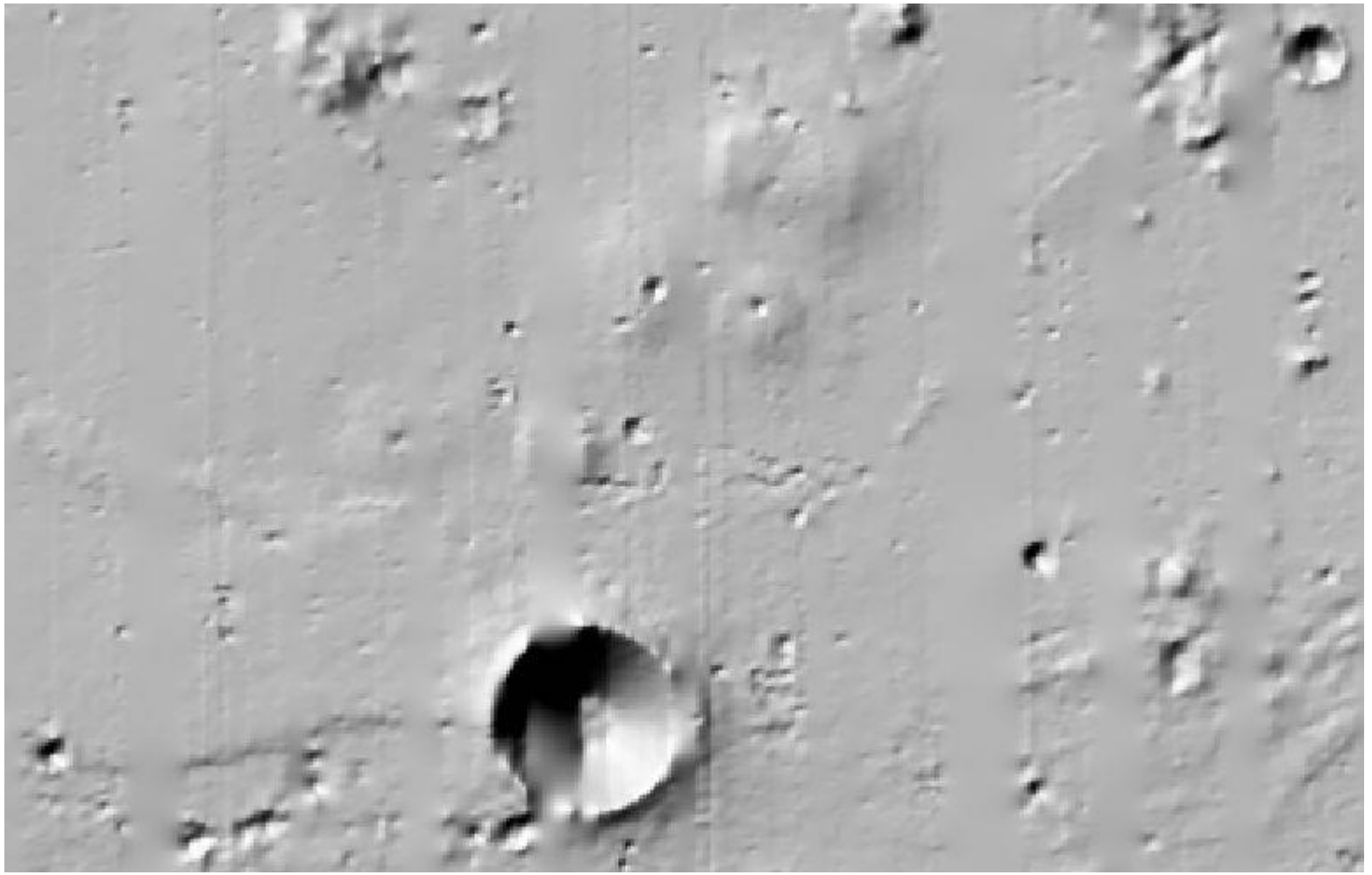
Same area, LRO Diviner Surface Temperature Mosaic 128ppd, Colorized

Time Series

We will be adding the ability to display time series data in a coming release.

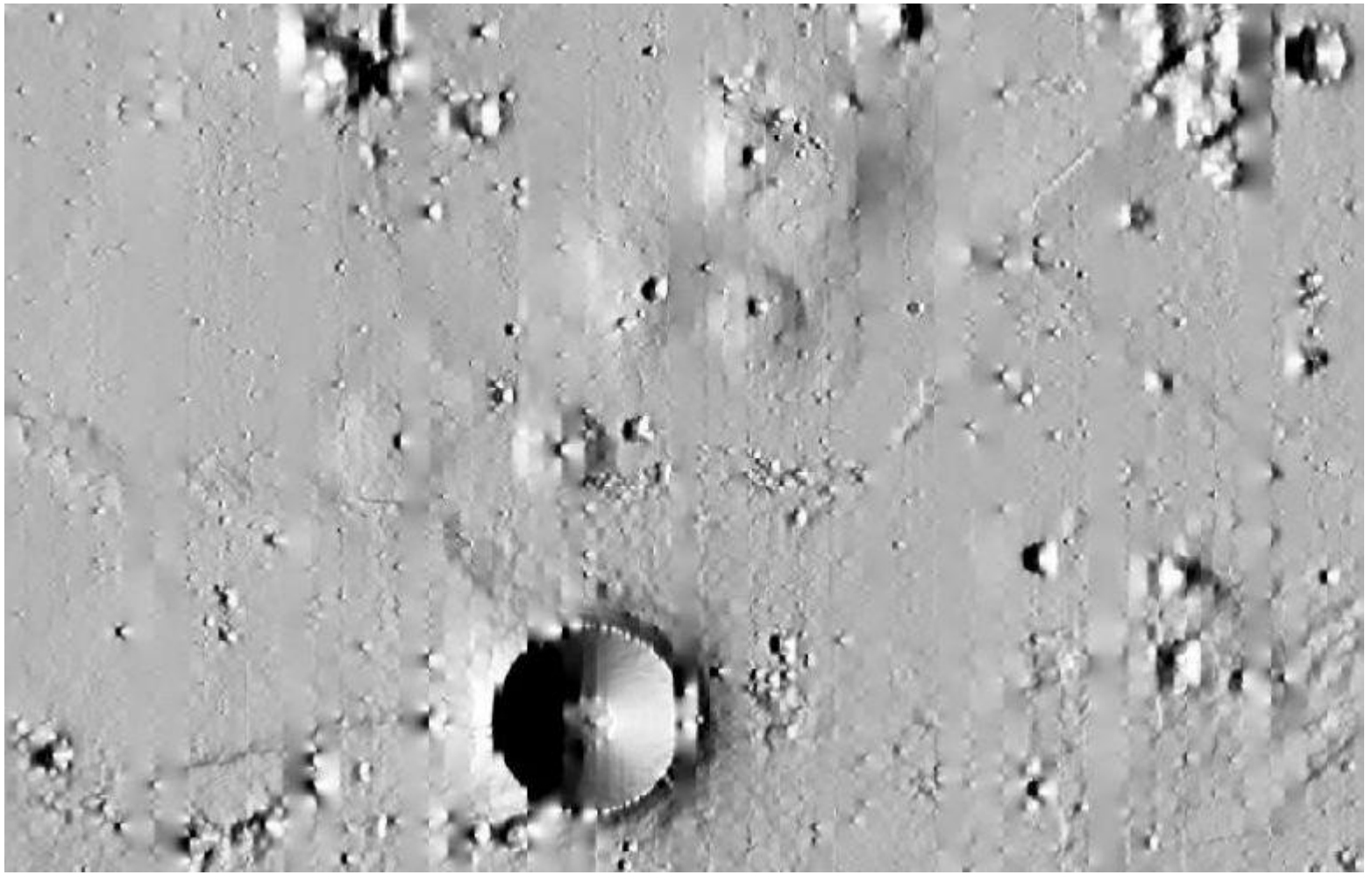
This will enable us to display Jean-Pierre Williams' temperature data featuring approximately a quarter trillion calibrated radiance measurements of the Moon, acquired over 5.5 years by Diviner, compiled into a 0.5° resolution global dataset with a 0.25 hour time resolution.

DEM Evolution



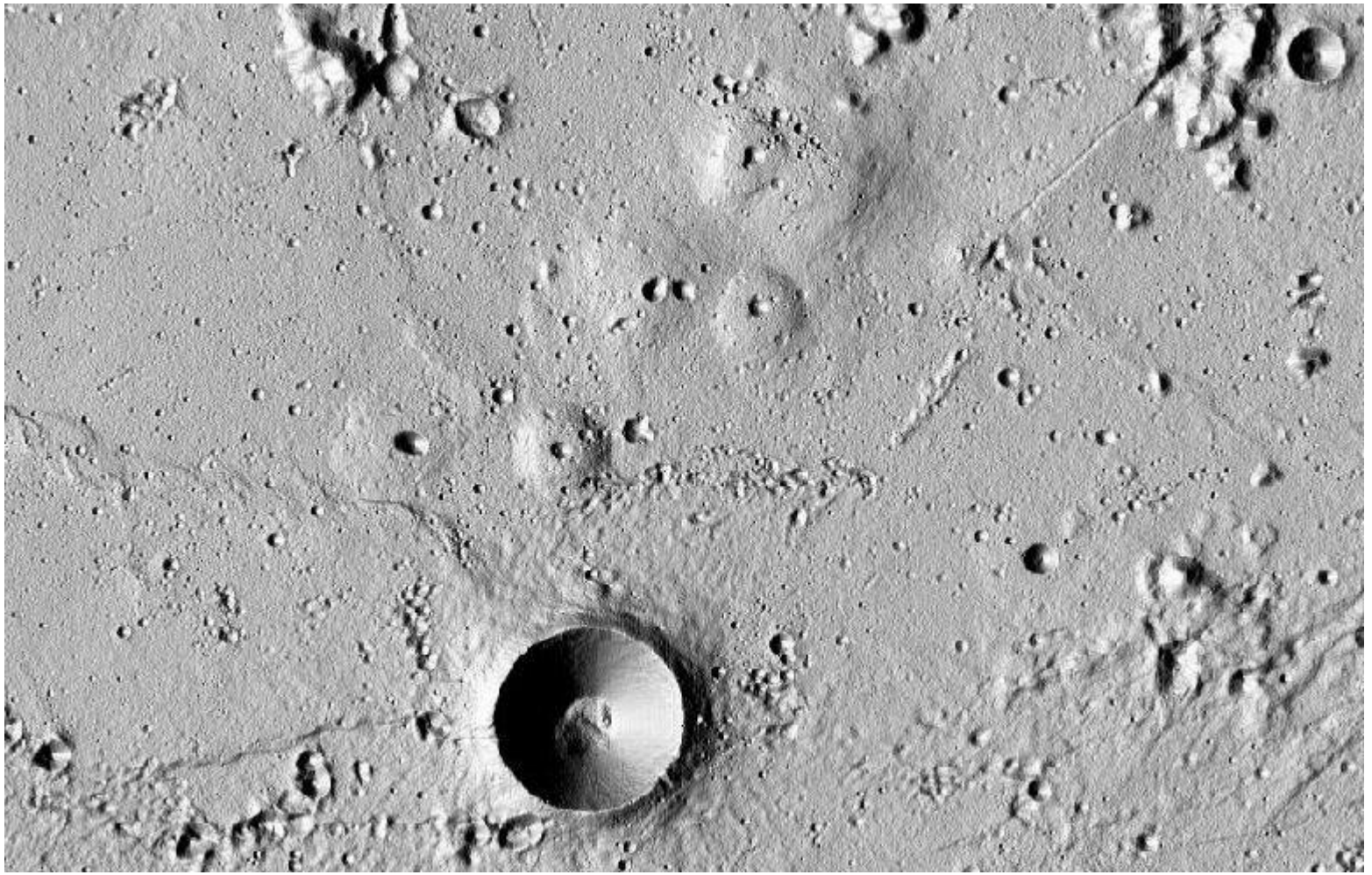
Hortensius Domes – LOLA V4

DEM Evolution



Hortensius Domes – LOLA V6

DEM Evolution

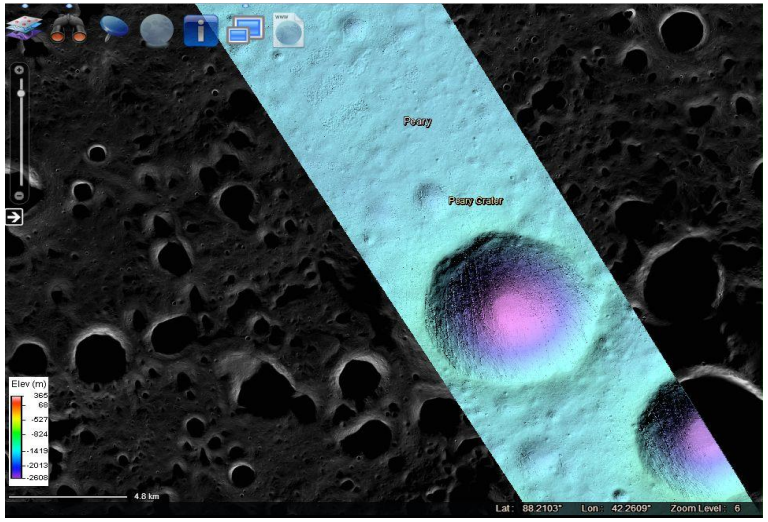


Hortensius Domes – LOLA and Kaguya Terrain Camera Stereo Merge

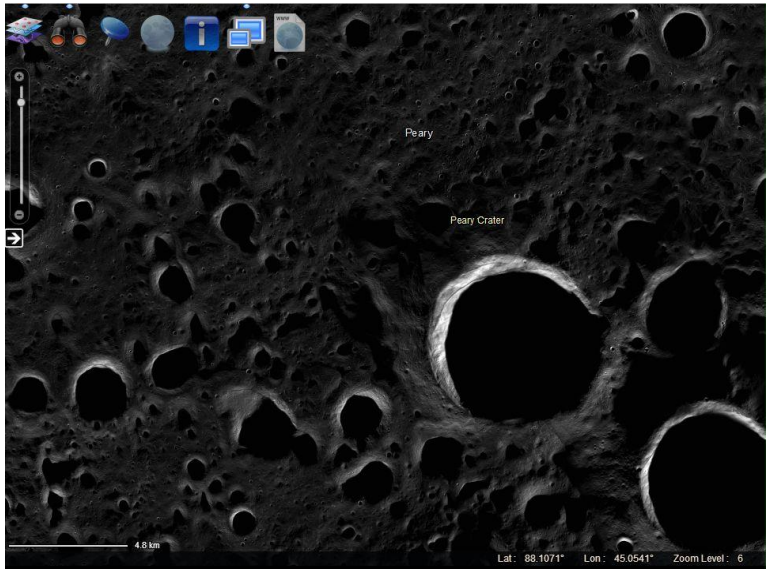
North Pole - Peary

Jet Propulsion Laboratory
California Institute of Technology

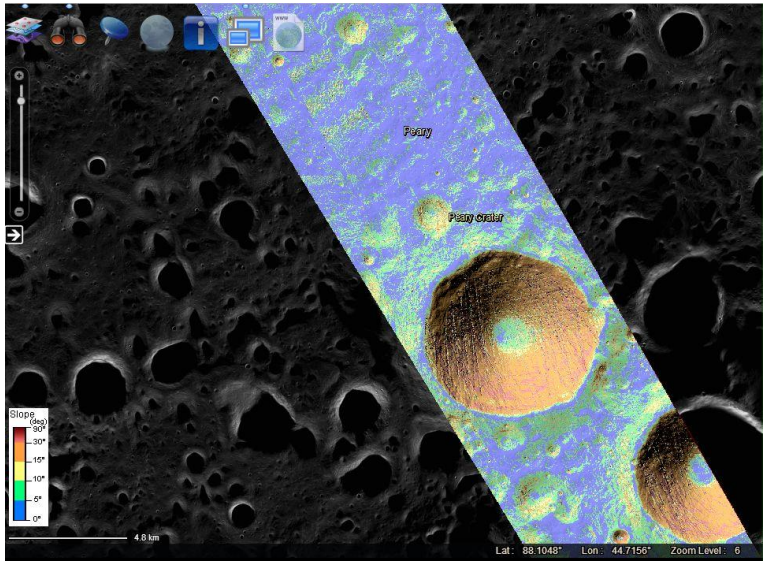
Elevation Map



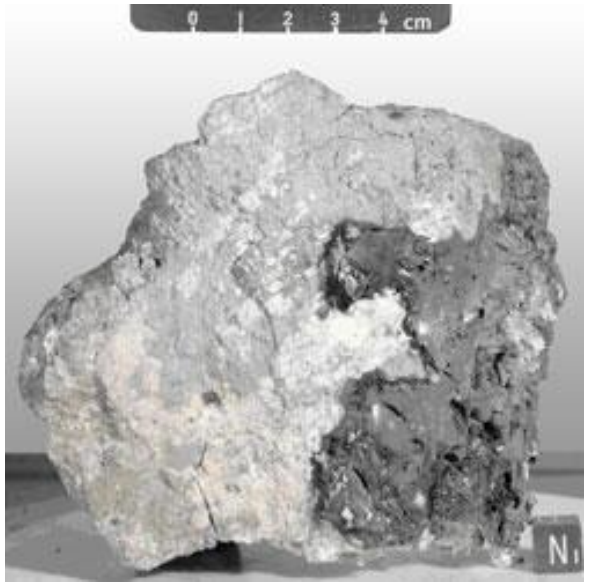
NAC Imagery

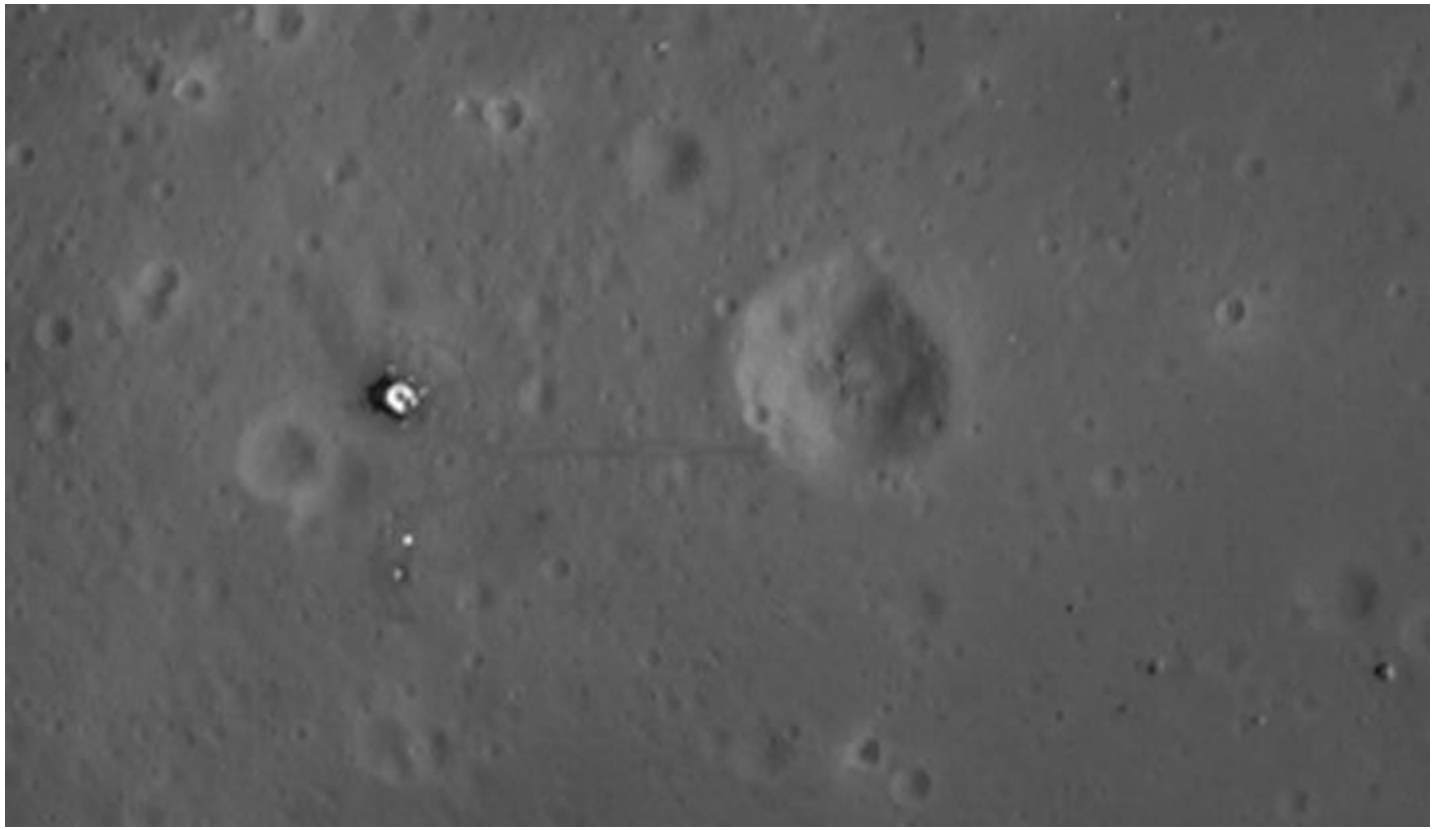


Slope Map



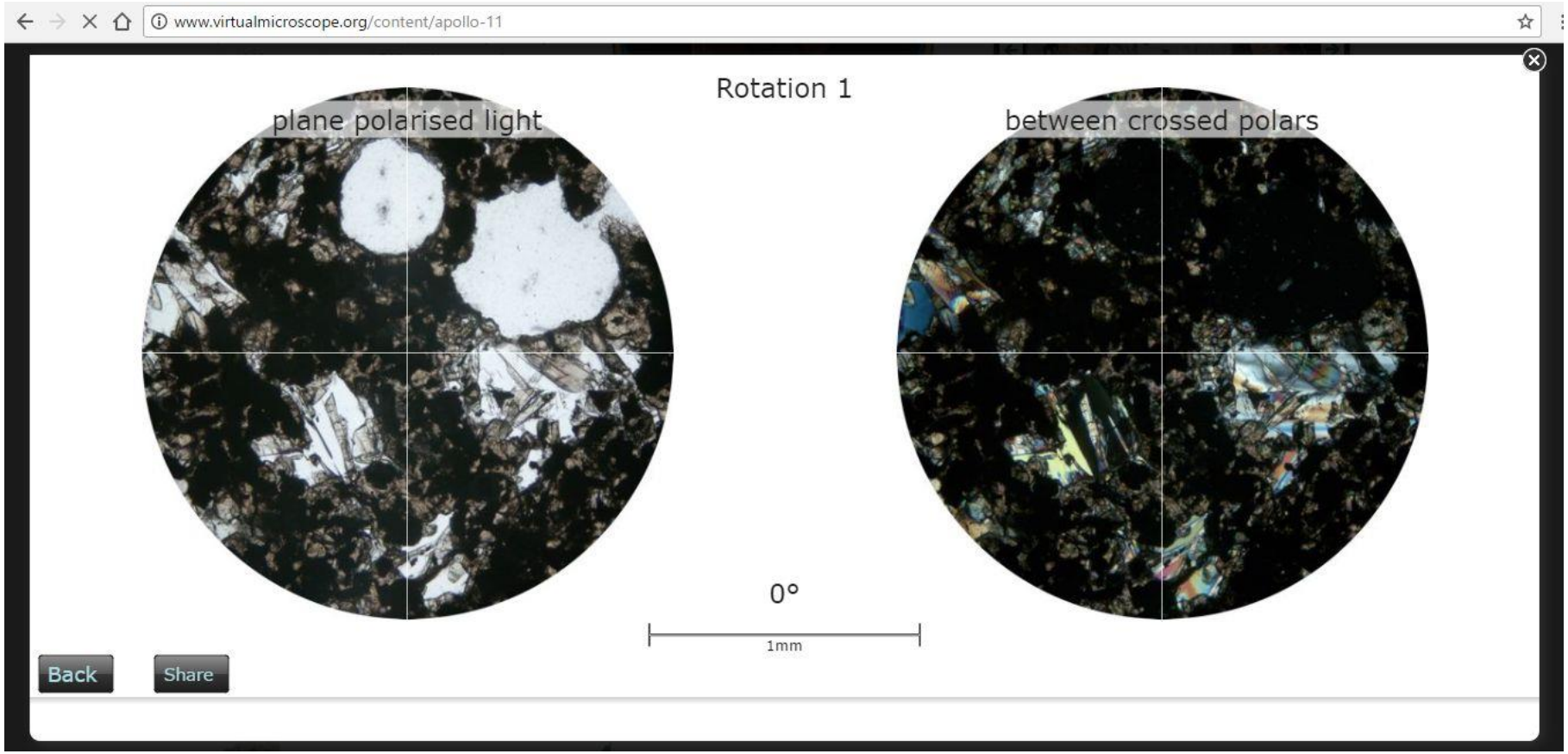
Looking Ahead





Collaborate with NASA Astromaterials Acquisition and Curation Office at JSC to be able to access their database of Apollo lunar samples, and with SSERVI researcher Noah Petro (RIS4E and FINESSE) to integrate his digitized Apollo traverses so as to be able to be able to enter an Apollo sample number into Moon Trek and have it take you to the location from which it was collected.

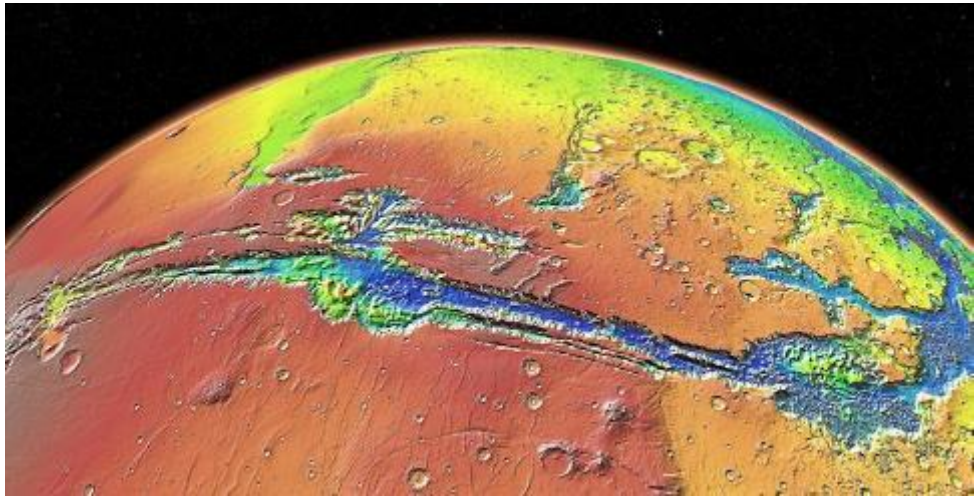
Virtual Microscope

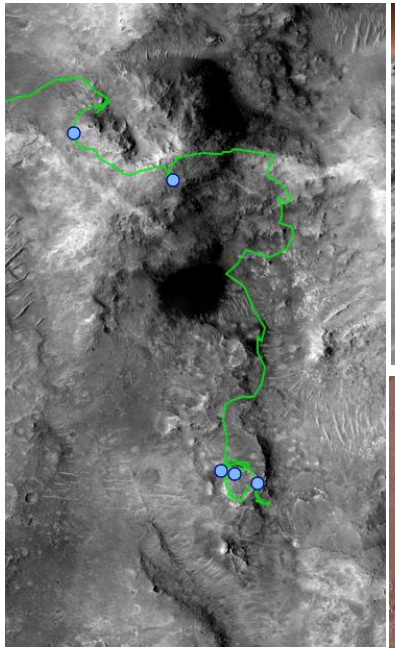


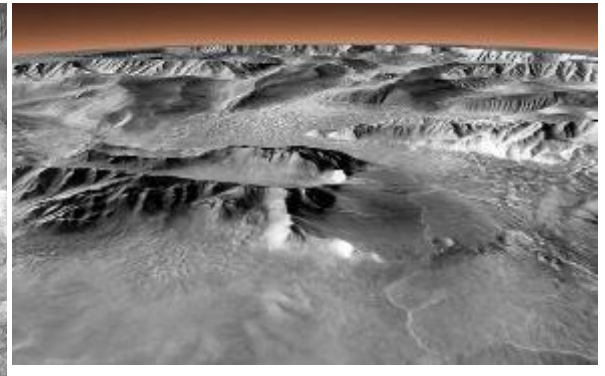
Enhance integration with lunar samples by linking to the Apollo samples in the Virtual Microscope from SSERVI's Open University UK International partner.

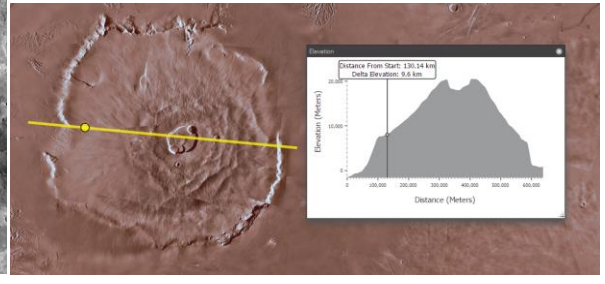
Mars Trek (https://marstrek.jpl.nasa.gov)

- Analysis tools
  - Distance, Profile, Sun Angle, Spacecraft Overhead
- Landing Site features
  - Viking, MER, MSL, Phoenix, Pathfinder
- Visualization (with overlays)
- 3D fly over and printing
- Data
  - Mars Reconnaissance Orbiter, Mars Odyssey, Mars Global Surveyor, Viking, Mars Express
- Users
  - EPO, Scientists







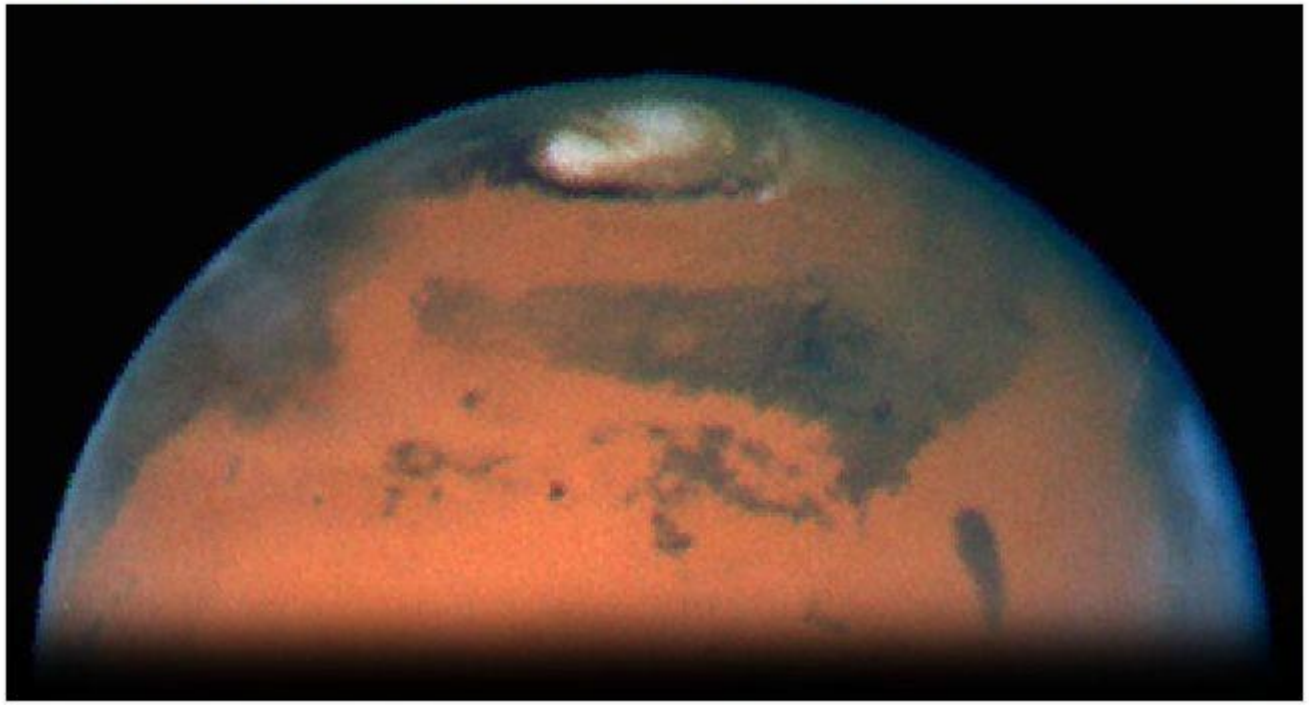


Mars Trek
(https://marstrek.jpl.nasa.gov)

Science

NASA pops open a big can of red planet whup-ass with Mars Trek

Stand on Olympus Mons, tallest mountain in the Solar System

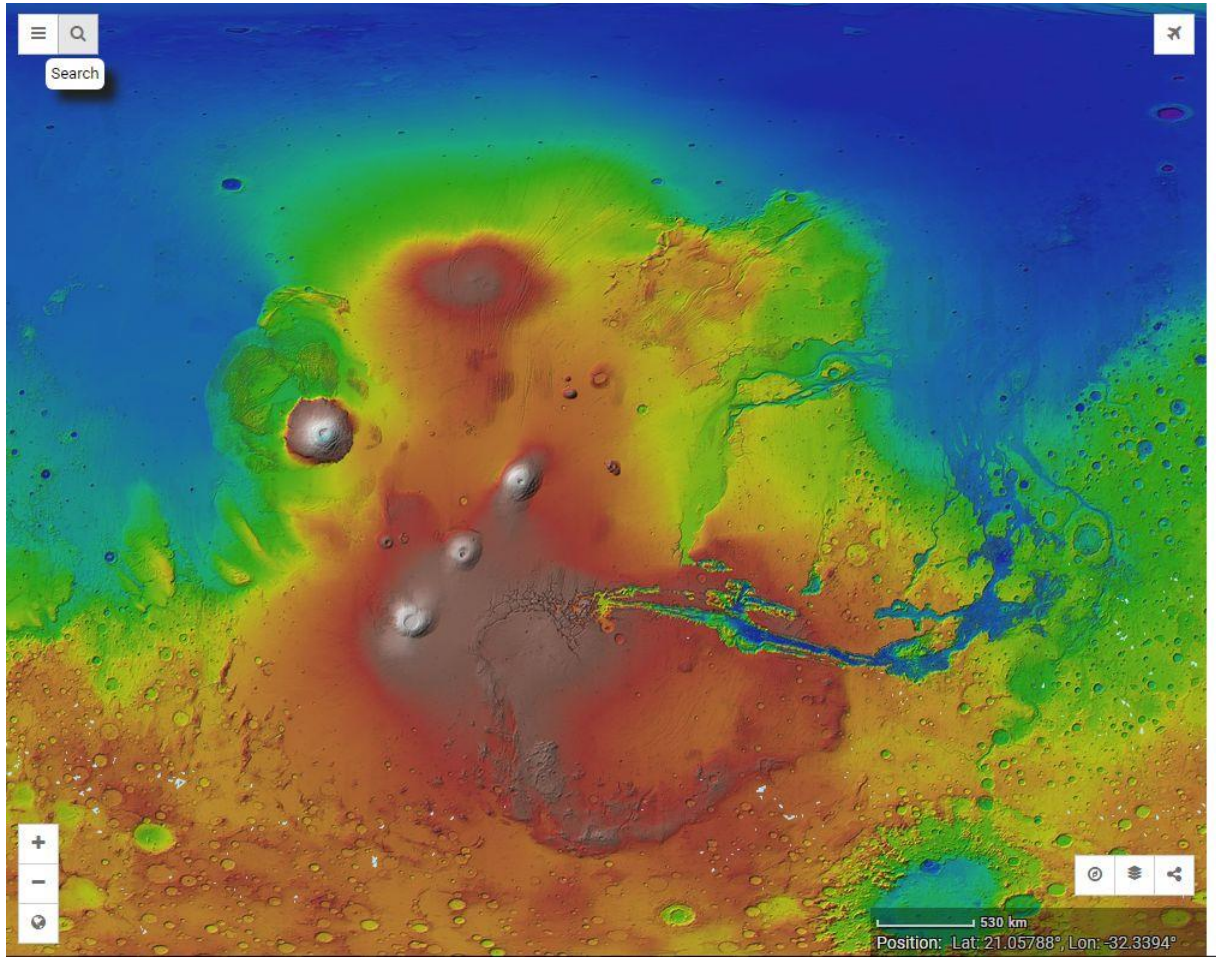


10 Jul 2015 at 13:57, Alexander J Martin

The Register, U.K., 5/10/15

Mars Trek

(https://marstrek.jpl.nasa.gov)

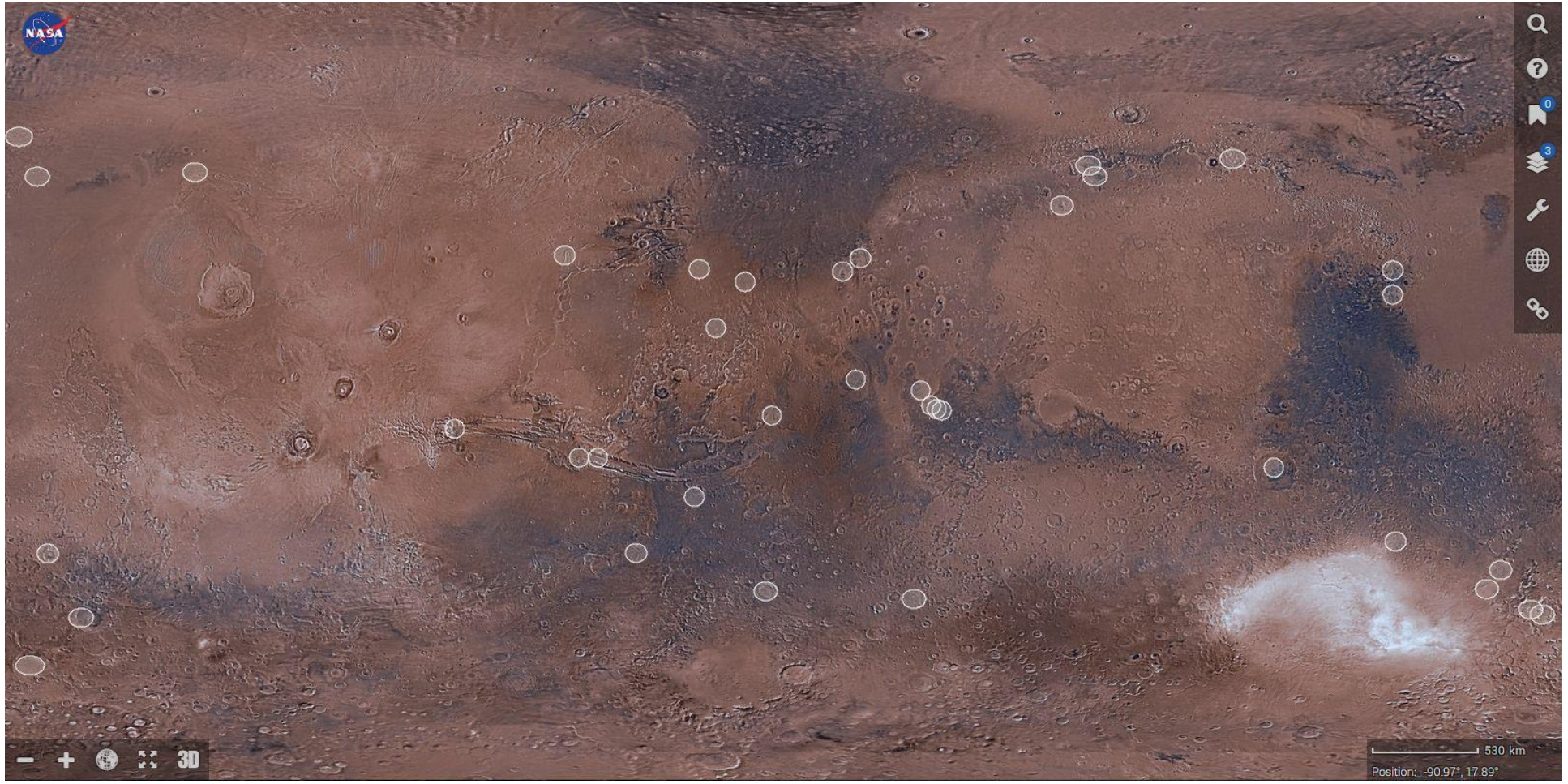


Tools

- Create Bookmark
- Generate 3D Print File
- Calculate Distance
- Calculate Elevation Profile
- Calculate Sun Angle
- Detect Craters
- Detect Rocks
- Subsetting
- Slope

Mars Trek

(https://marstrek.jpl.nasa.gov)



Mars Exploration Zones

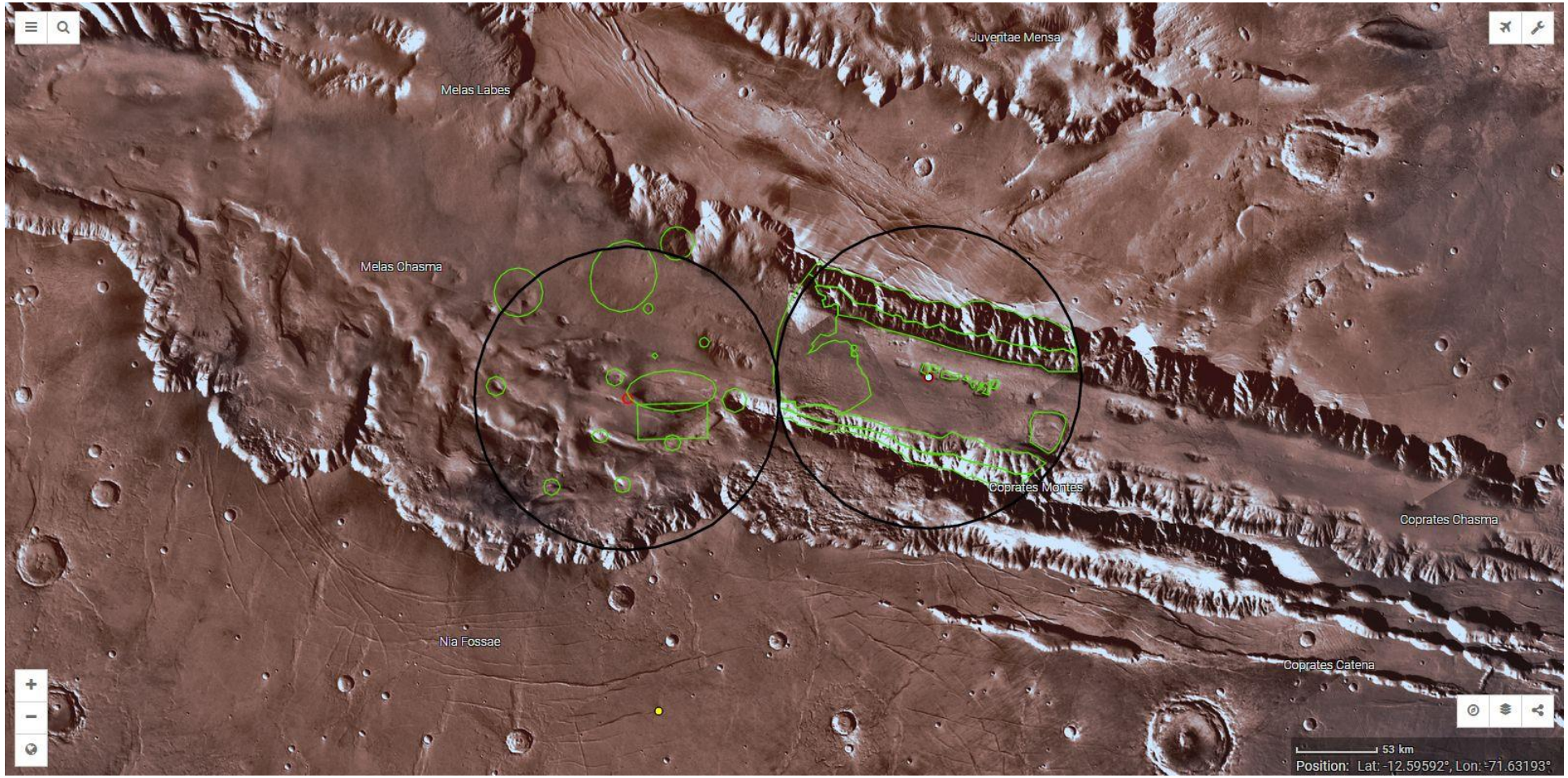
Mars Trek

(https://marstrek.jpl.nasa.gov)

Mars Exploration Zones

Mars Trek

(https://marstrek.jpl.nasa.gov)



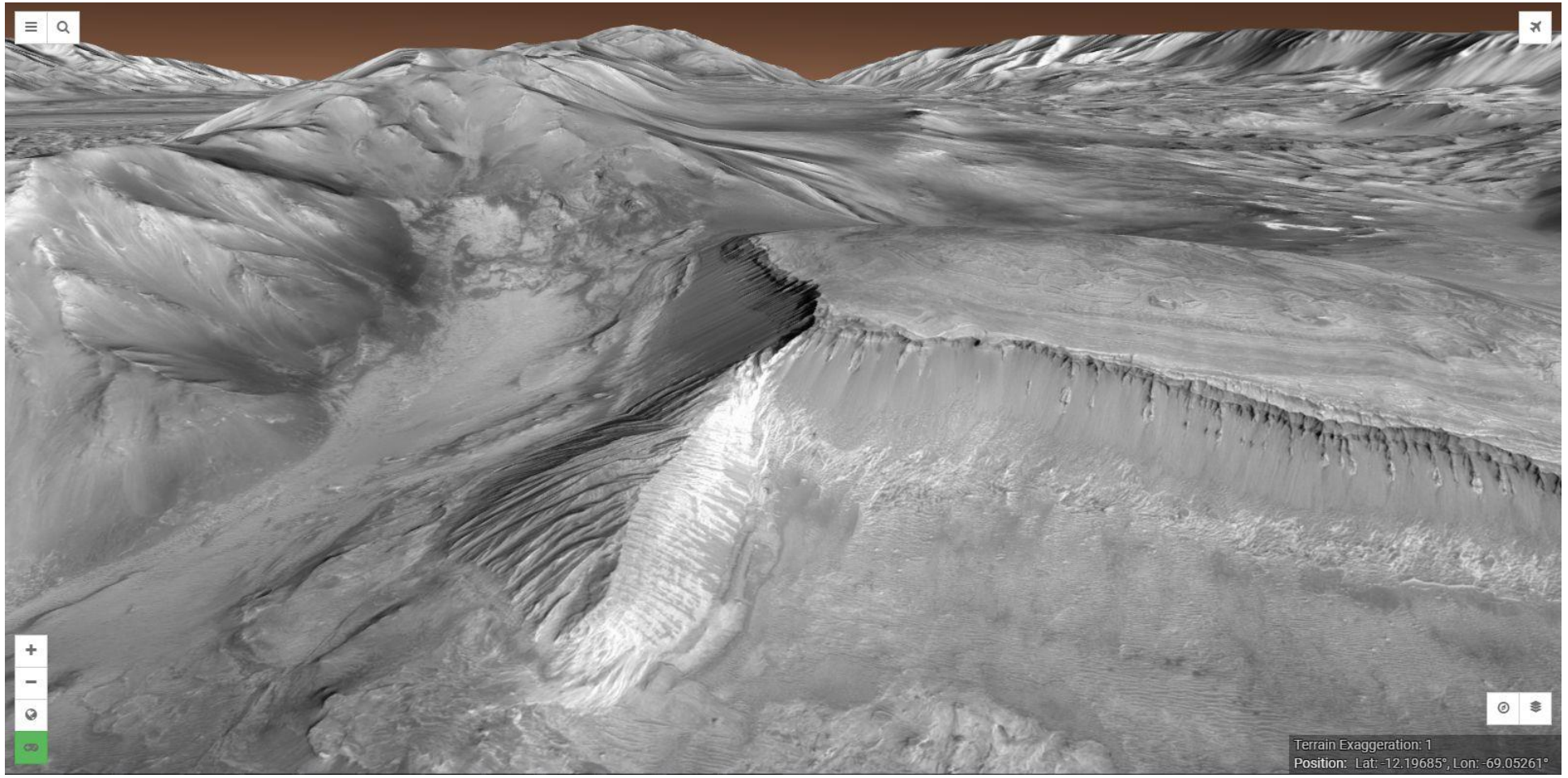
Mars Exploration Zones

Insert VM movie here.

Mars Trek

(https://marstrek.jpl.nasa.gov)

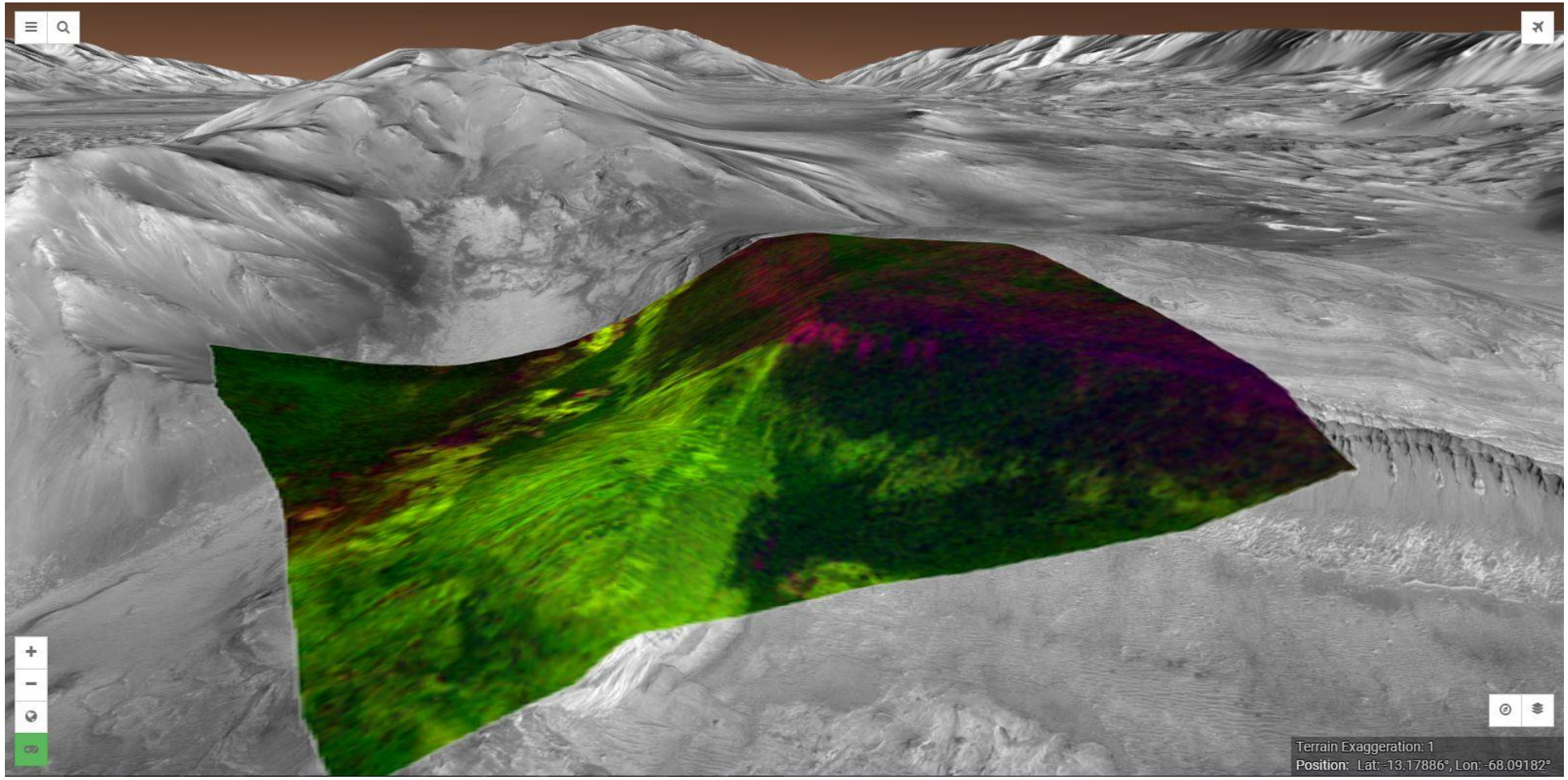
Jet Propulsion Laboratory
California Institute of Technology



Valles Marineris – Eastern Melas Chasma
CTX Mosaic

Mars Trek

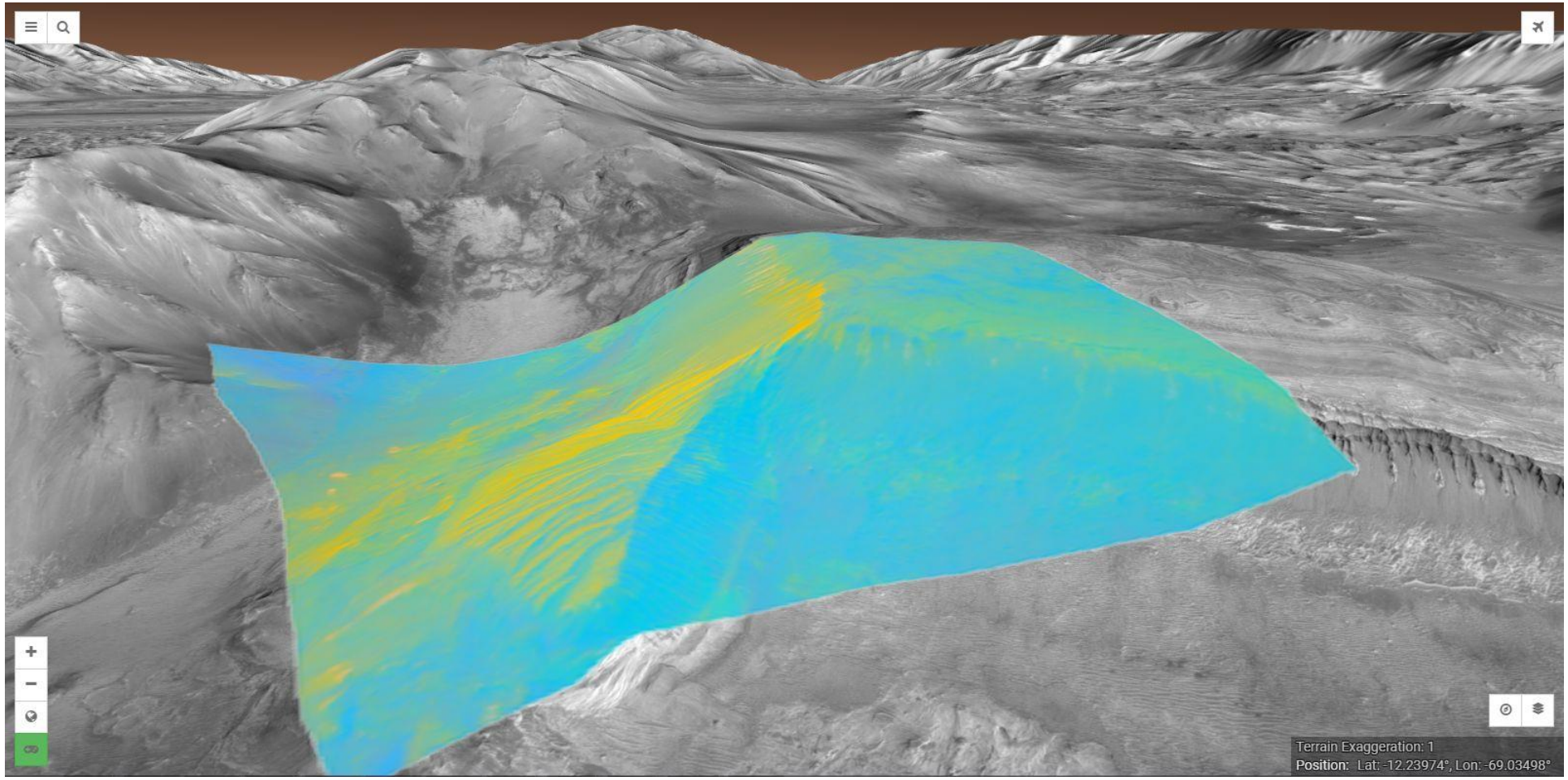
(https://marstrek.jpl.nasa.gov)



Valles Marineris – Eastern Melas Chasma
CTX Mosaic with overlay of CRISM Bound Water Polyhydrated Sulfates

Mars Trek

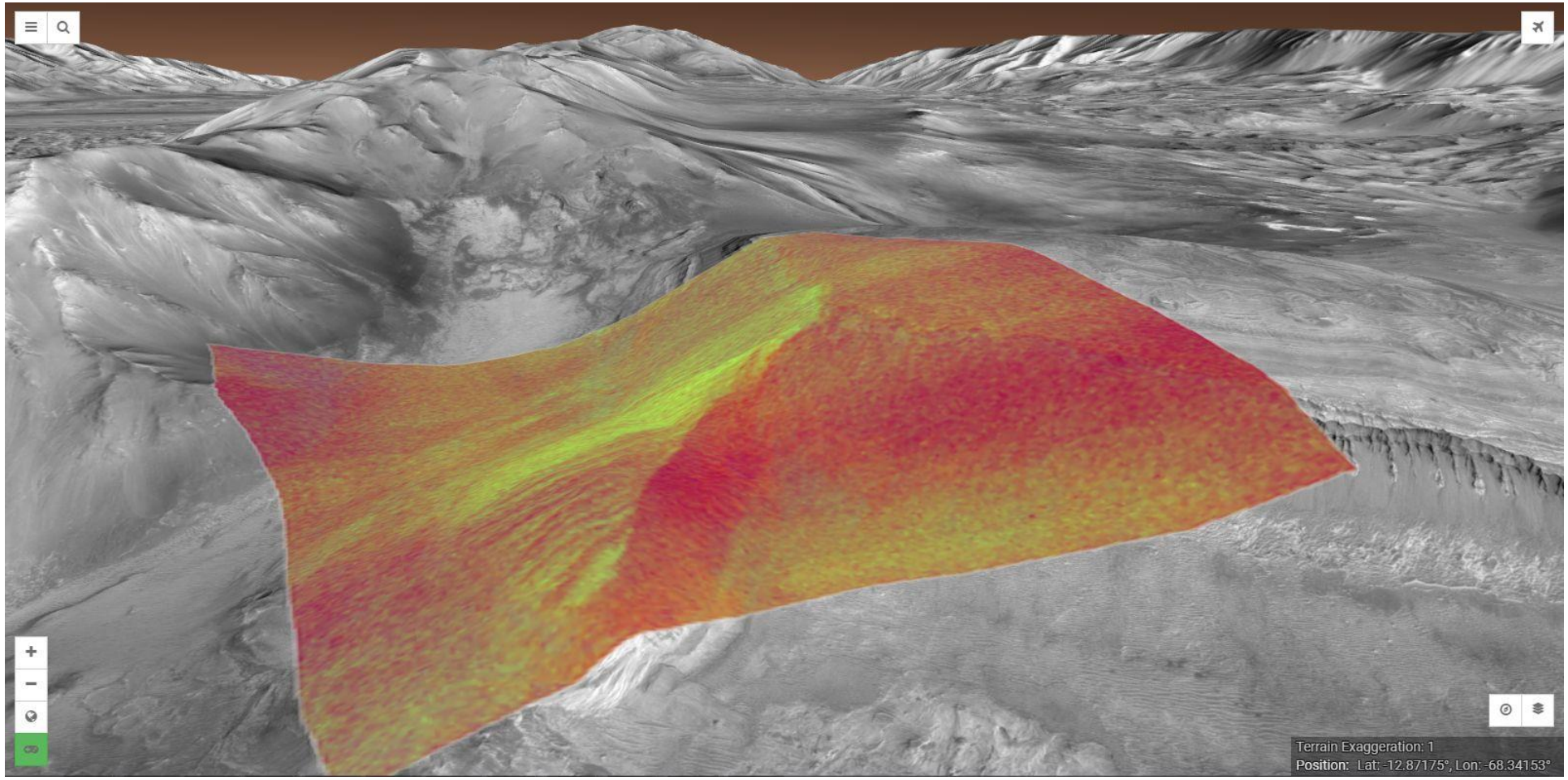
(https://marstrek.jpl.nasa.gov)



Valles Marineris – Eastern Melas Chasma
CTX Mosaic with overlay of CRISM Chloride Deposits

Mars Trek

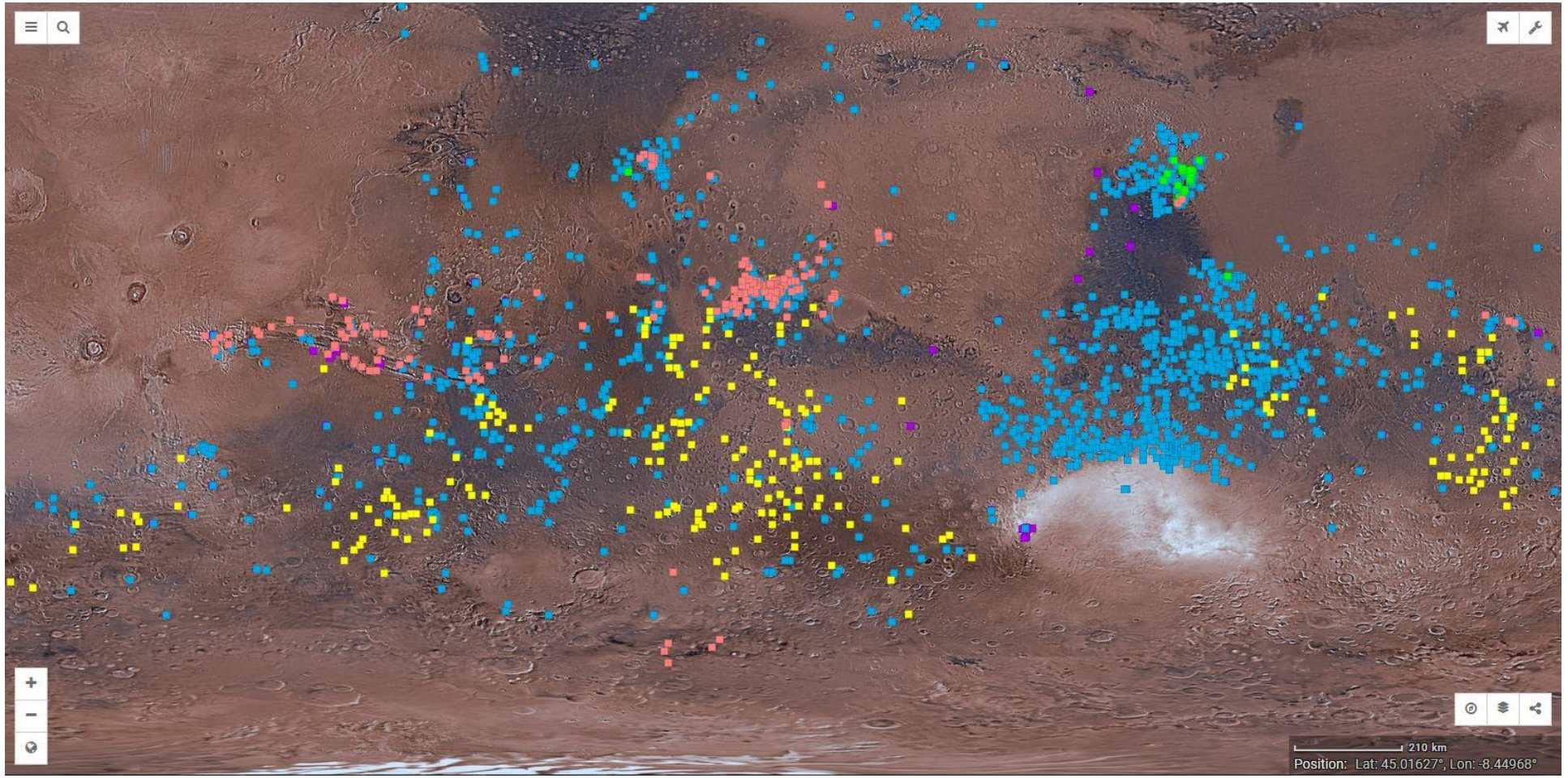
(https://marstrek.jpl.nasa.gov)



Valles Marineris – Eastern Melas Chasma
CTX Mosaic with overlay of CTX Iron Minerals

Mars Trek

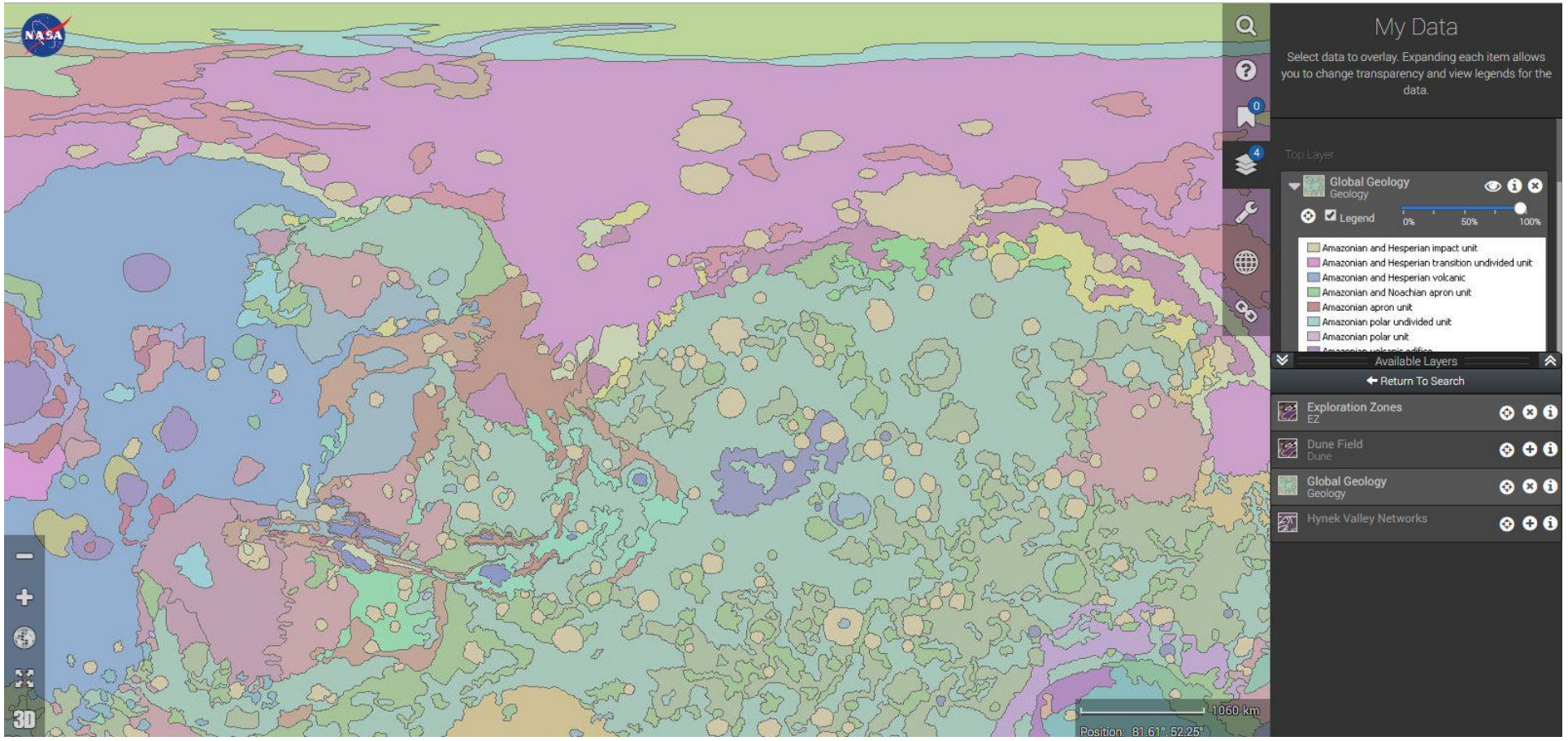
(https://marstrek.jpl.nasa.gov)



Hydrous Mineral Detections

Mars Trek

(https://marstrek.jpl.nasa.gov)



Global Geologic Map

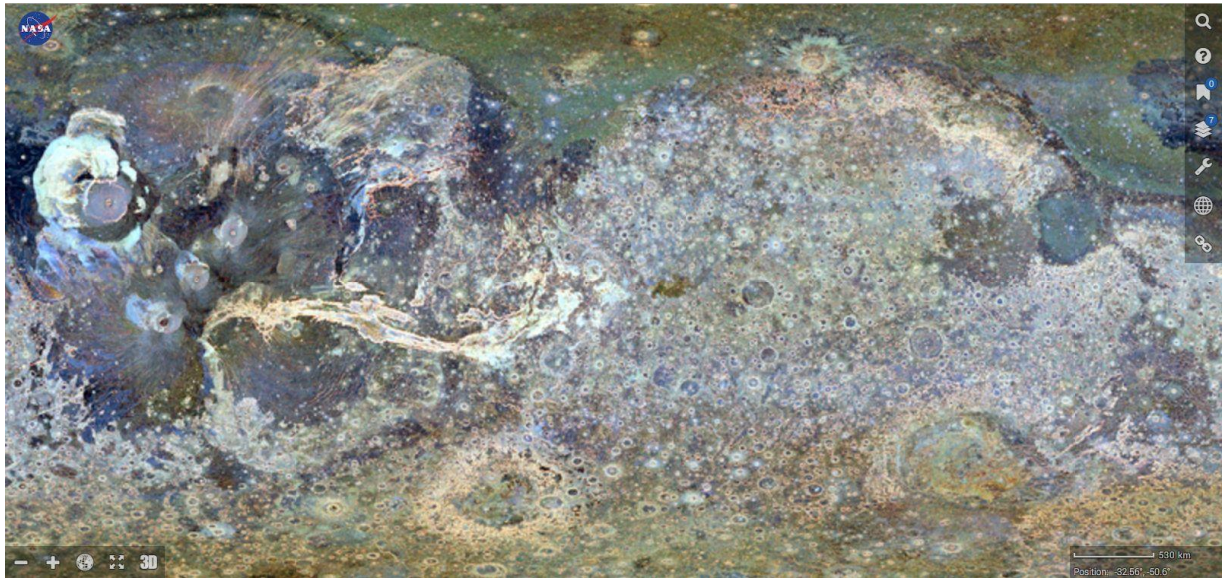
Mars Trek

(https://marstrek.jpl.nasa.gov)

Jet Propulsion Laboratory
California Institute of Technology

Some Additional Layers

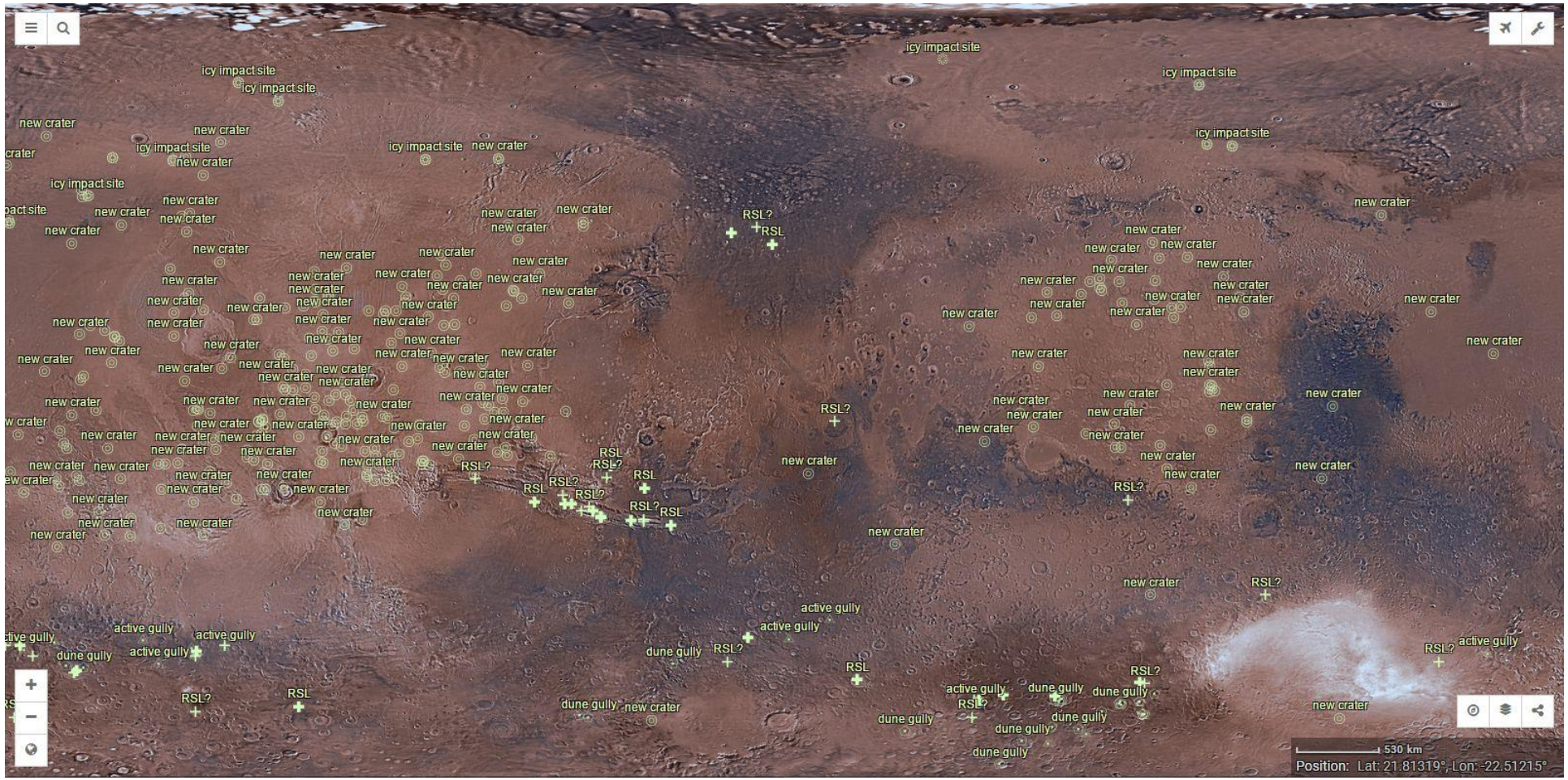
Hydrous Mineral Detections, Chloride Survey, Aqueous Mineral Distribution
CRISM: Carbonate Minerals Fe-Mg, Carbonate Minerals Mg, Infrared False Color, Olivine and Pyroxene Minerals, Hydrated Silica and Al-OH Minerals, Carbon Dioxide Frost or Ice, Mafic Minerals, Hydroxylated Minerals Including Al-Phyllosilicates and Hydrated Silica, Hydroxylated Minerals Including Fe-Mg-Phyllosilicates, Hydroxylated Minerals Including Fe-Mg-OH Phyllosilicates
TES: Albedo Mosaic, Thermal Inertia, High-CA Pyroxene, Plagioclase, Sheet Silicates/High-Si Glass, Surface Dust, TES Dust Cover Index



MOLA Vertical Roughness

Mars Trek

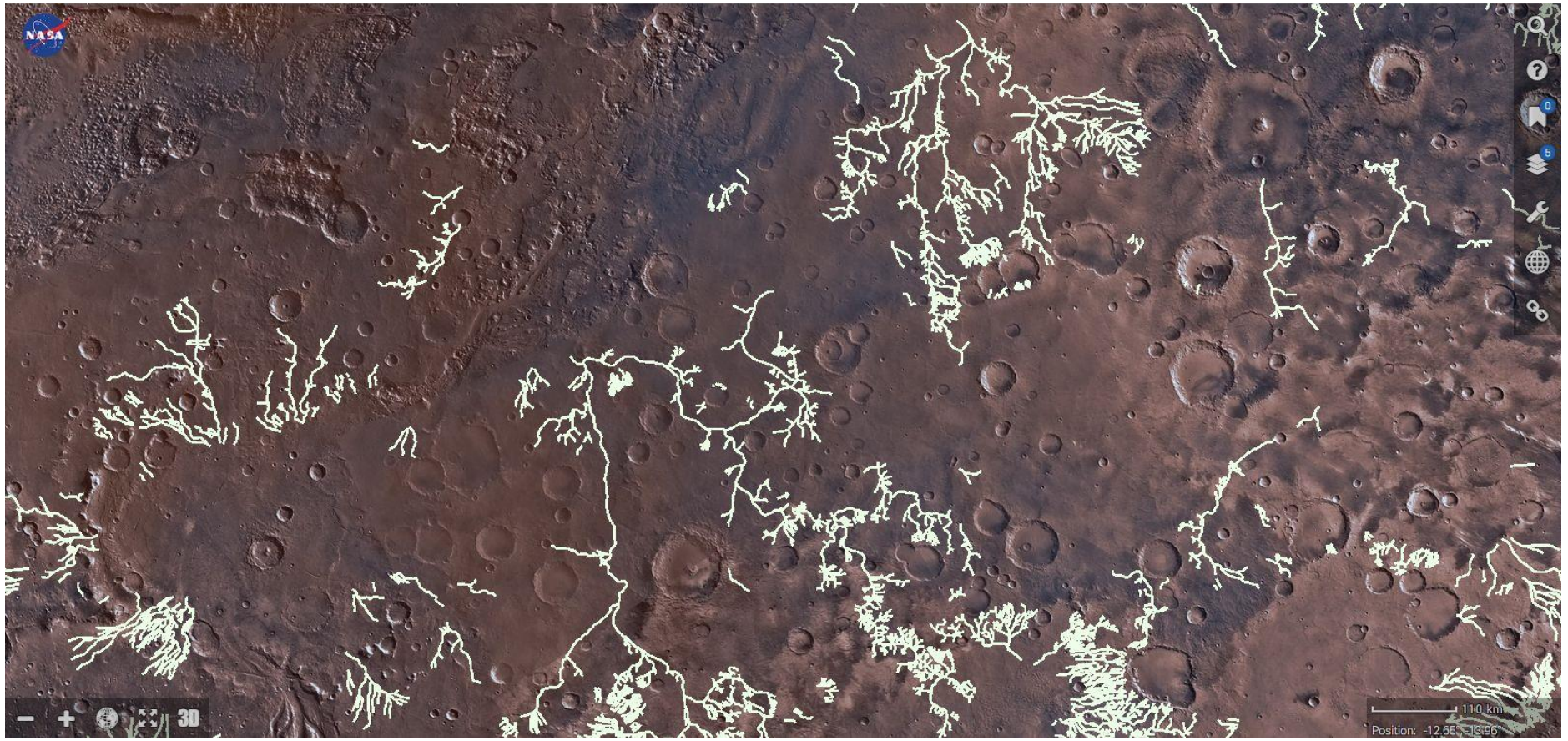
(https://marstrek.jpl.nasa.gov)



RSLs, New Craters, and Active Gullies

Mars Trek

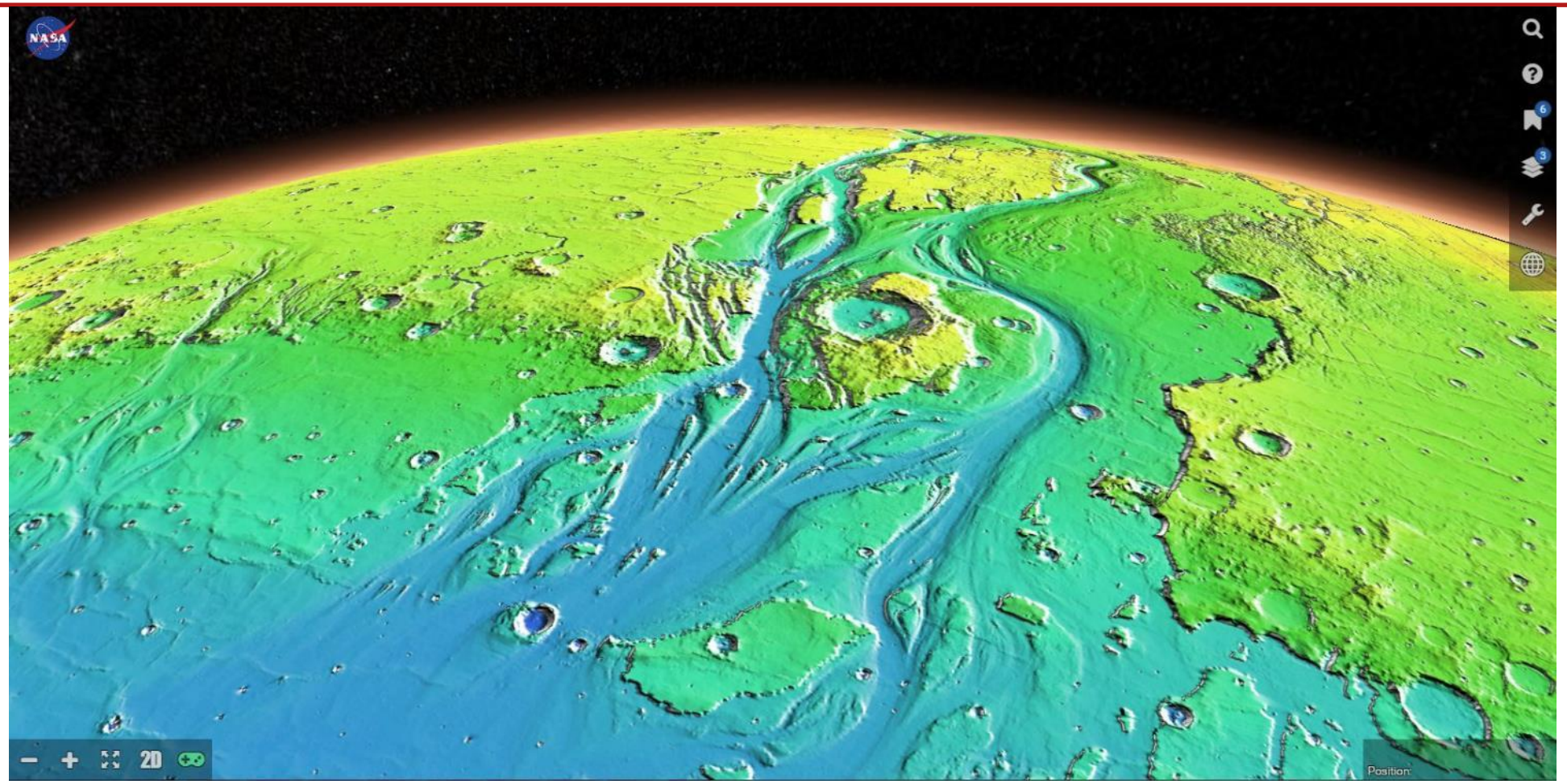
(https://marstrek.jpl.nasa.gov)



Mars Valley Networks (Hynek et al 2010)

Mars Trek

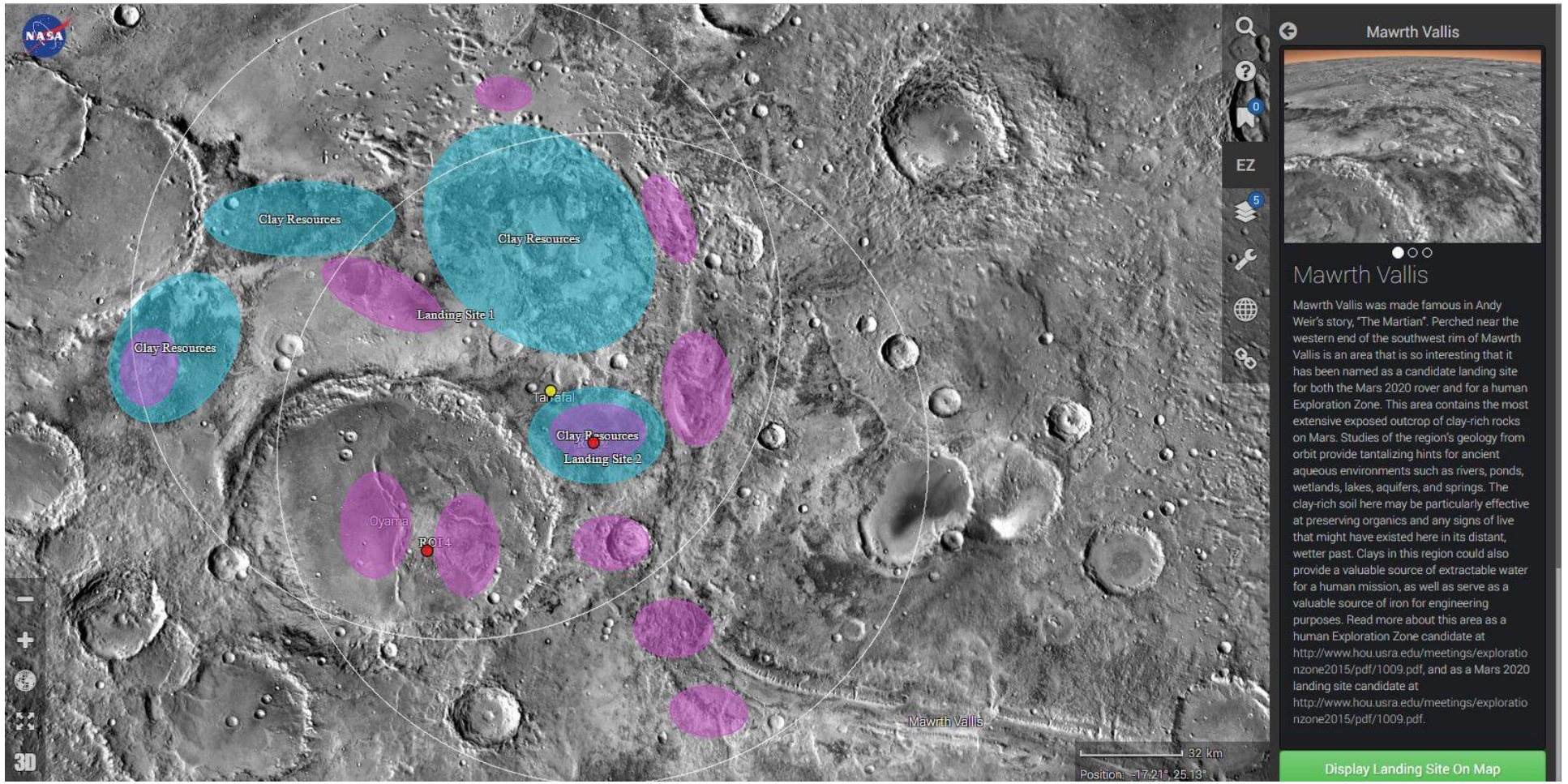
(https://marstrek.jpl.nasa.gov)



Kasei Valles: MOLA laser altimetry data from the Mars Global Surveyor spacecraft.

Mars Trek

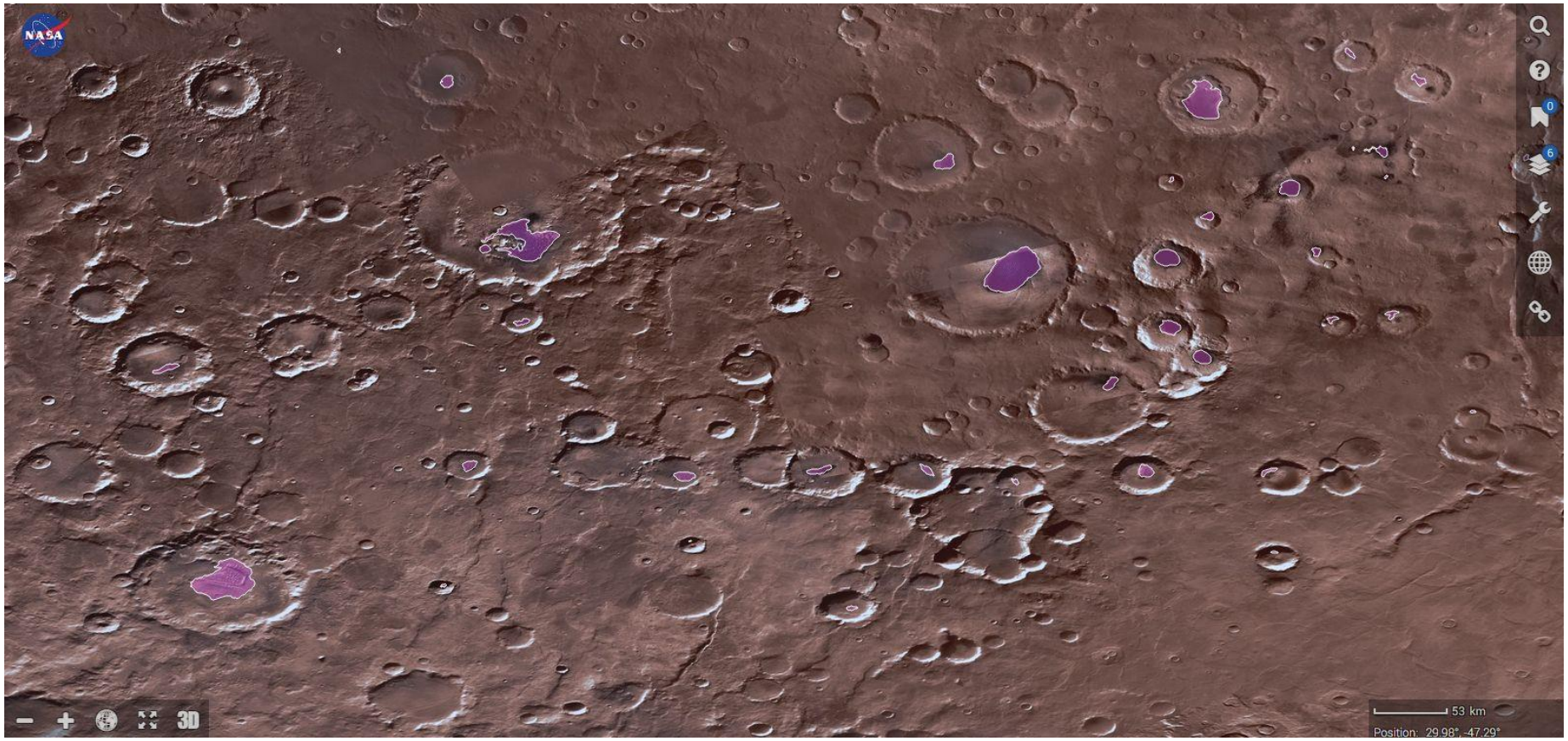
(https://marstrek.jpl.nasa.gov)



Mars Exploration Zones

Mars Trek

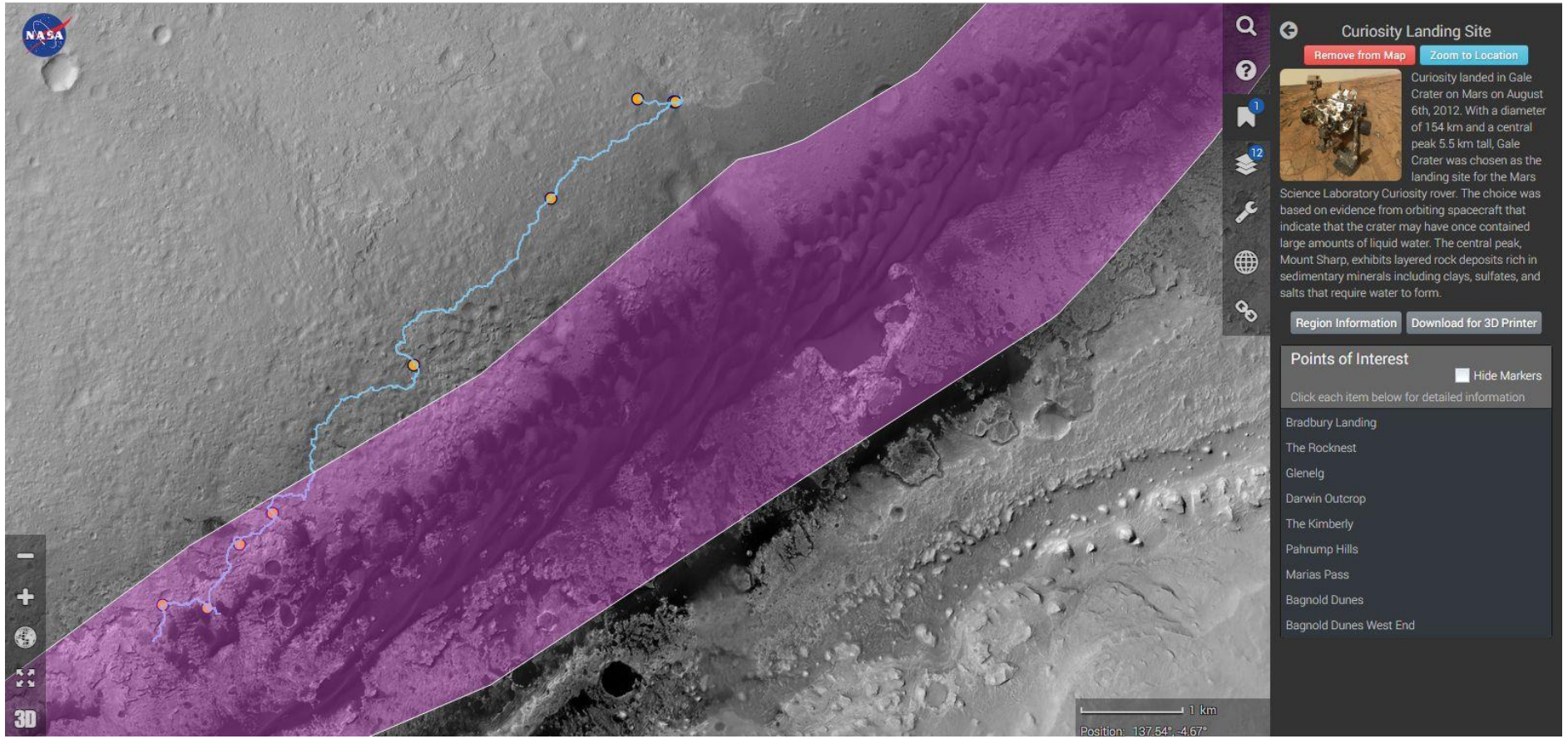
(https://marstrek.jpl.nasa.gov)



Mars Dune Fields (Hayward et al, 2007))

Mars Trek

(https://marstrek.jpl.nasa.gov)



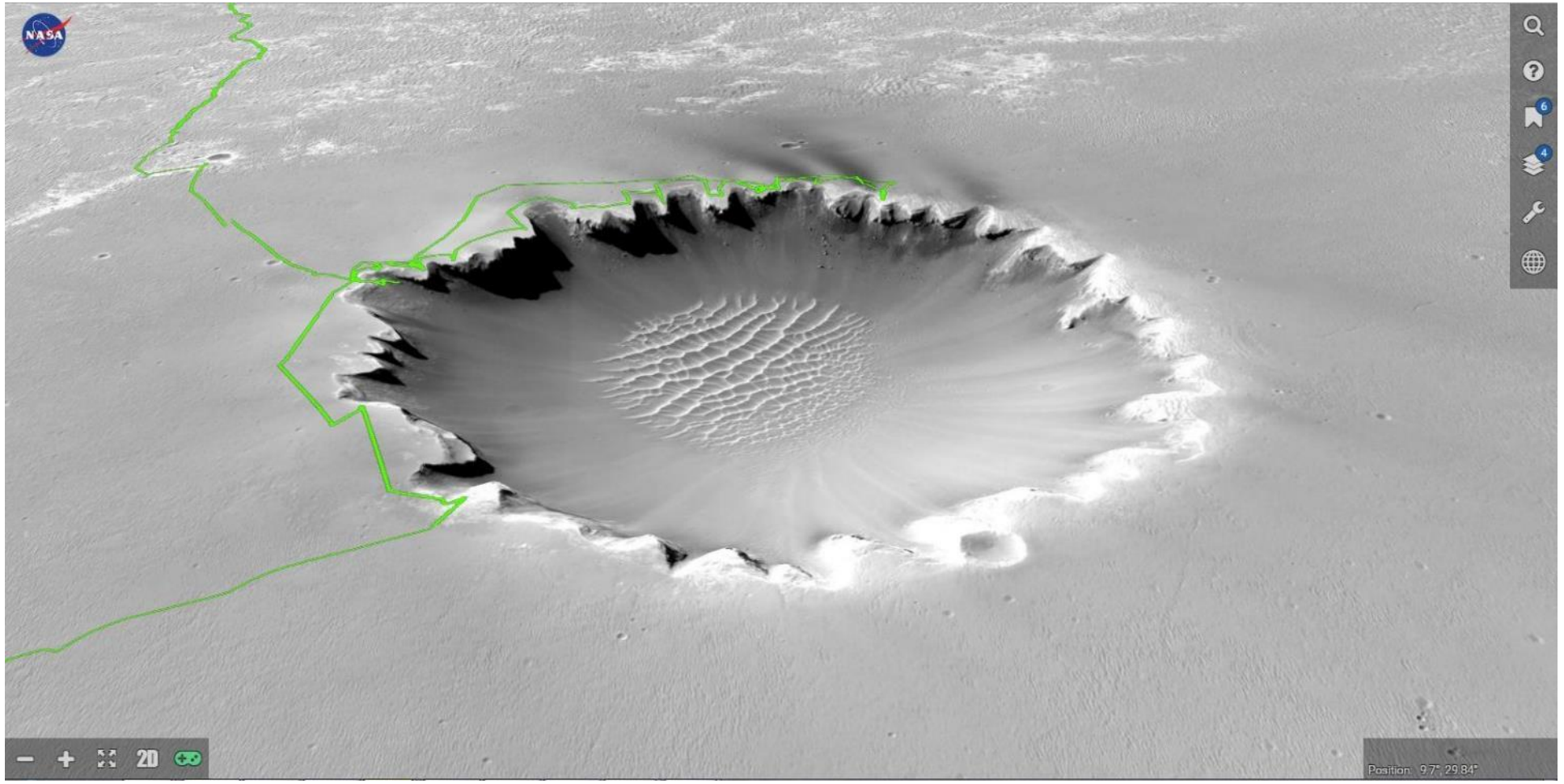
The Bagnold Dunes in Gale Crater and the path of the Curiosity Rover

Insert Gale movie here.

Insert Gusev movie here.

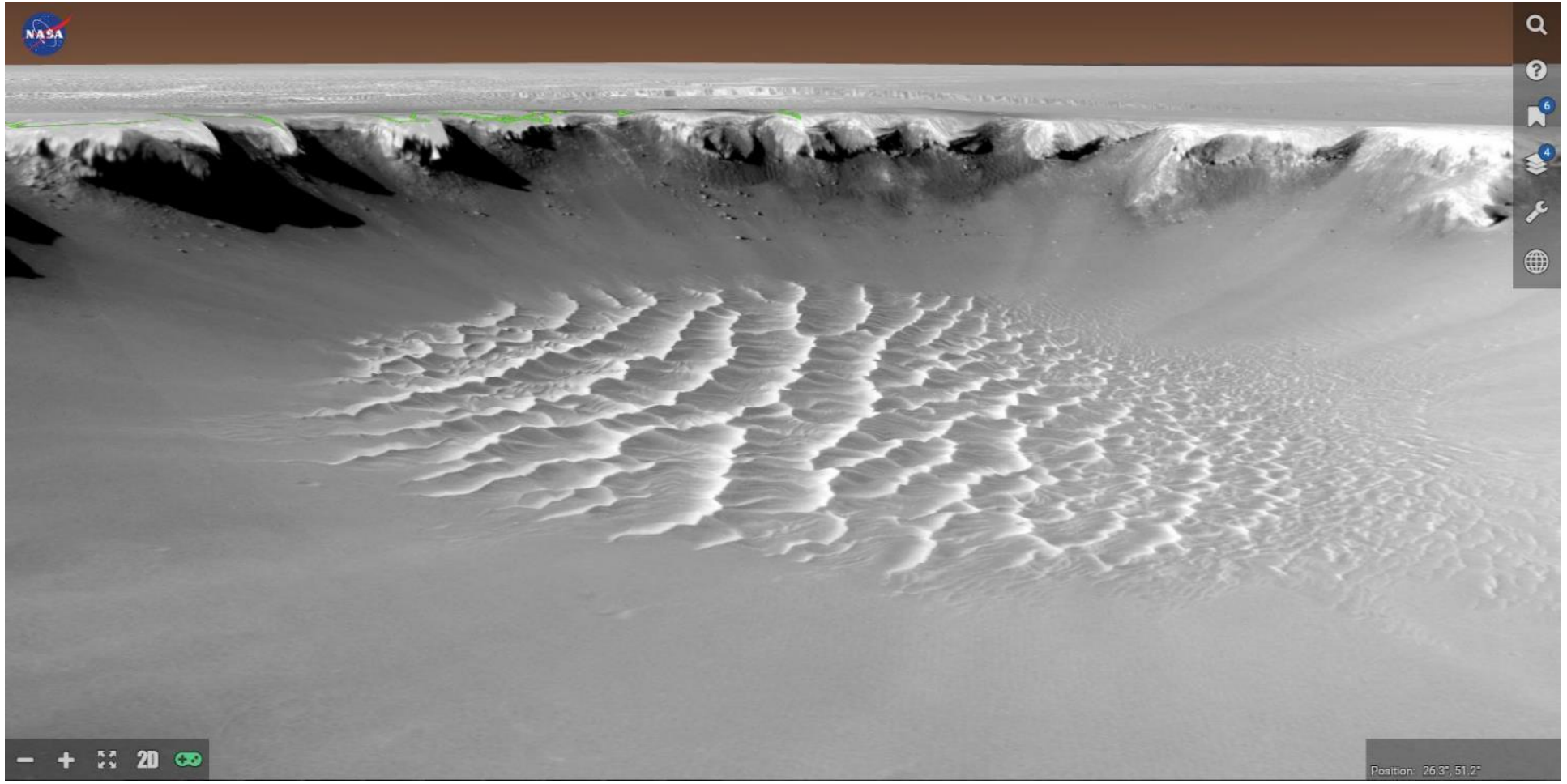
Insert Jezero movie here.

Mars Trek
(http://marstrek.jpl.nasa.gov)



Victoria Crater: Visualization using data from the HiRISE camera aboard the Mars Reconnaissance Orbiter. Opportunity's path here in green.

Mars Trek (https://marstrek.jpl.nasa.gov)

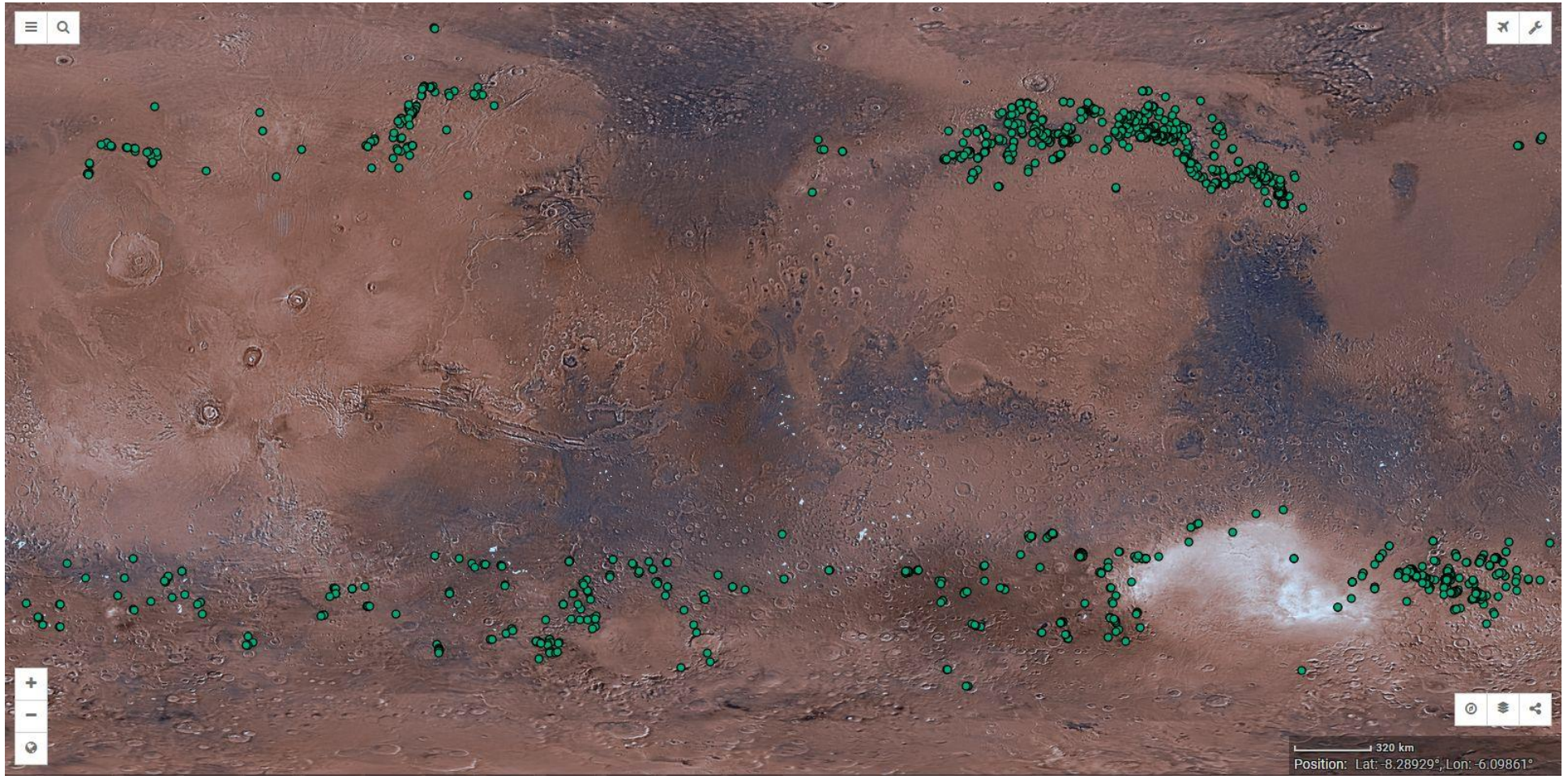


Victoria Crater: Ground level view using data from the HiRISE camera aboard the Mars Reconnaissance Orbiter. Opportunity's path here in green.

Insert McLaughlin movie here.

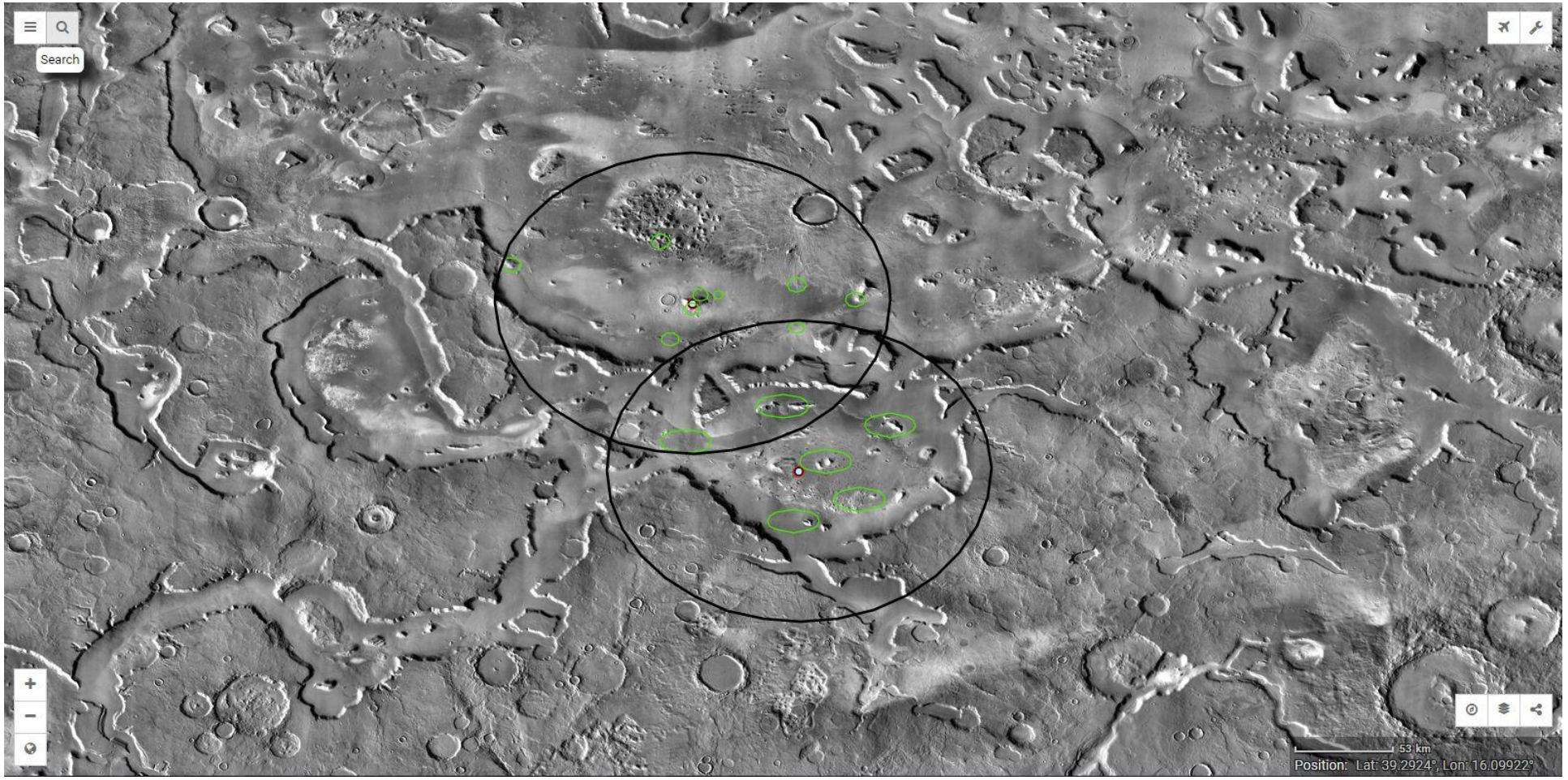
Mars Trek

(https://marstrek.jpl.nasa.gov)



Glacial landforms showing belts of mid-latitude glaciers

Mars Trek
(http://marstrek.jpl.nasa.gov)

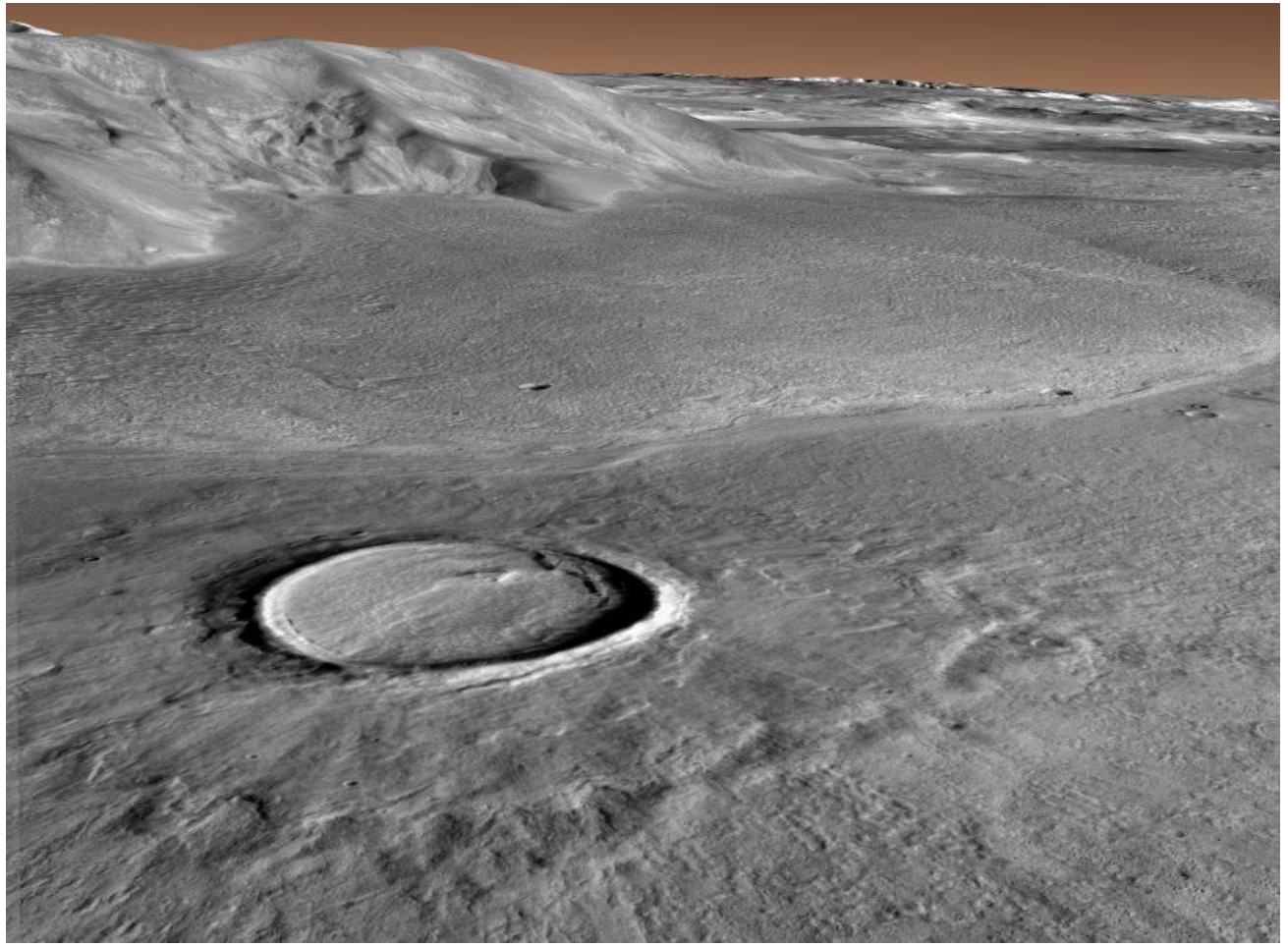


Exploration Zones in the Deuteronilus Mensae region

Insert Deut movie here.

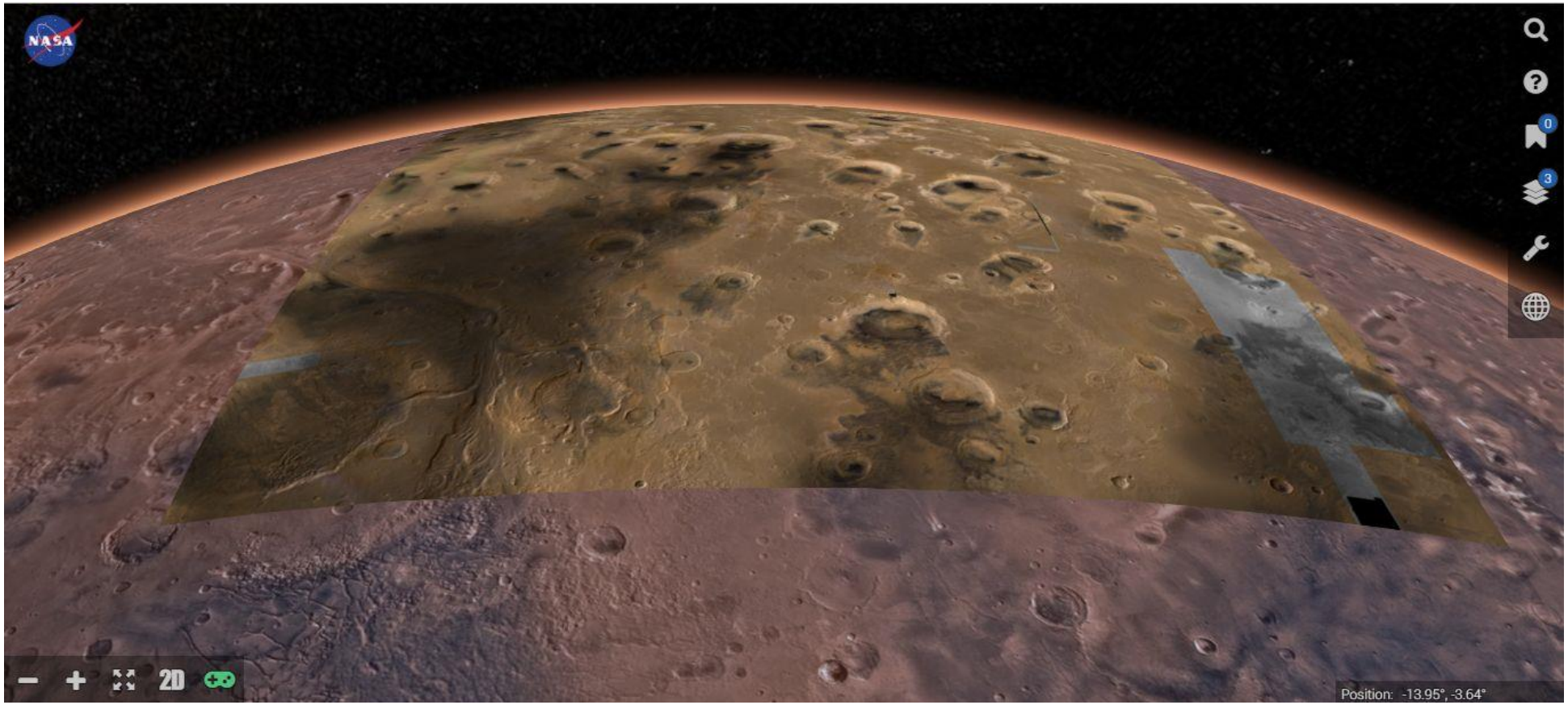
Mars Trek

(https://marstrek.jpl.nasa.gov)



CTX Mosaic: Rampart crater and lobate debris apron north of Reull Vallis

Mars Trek
(http://marstrek.jpl.nasa.gov)



Mars Express HRSC Mosaics

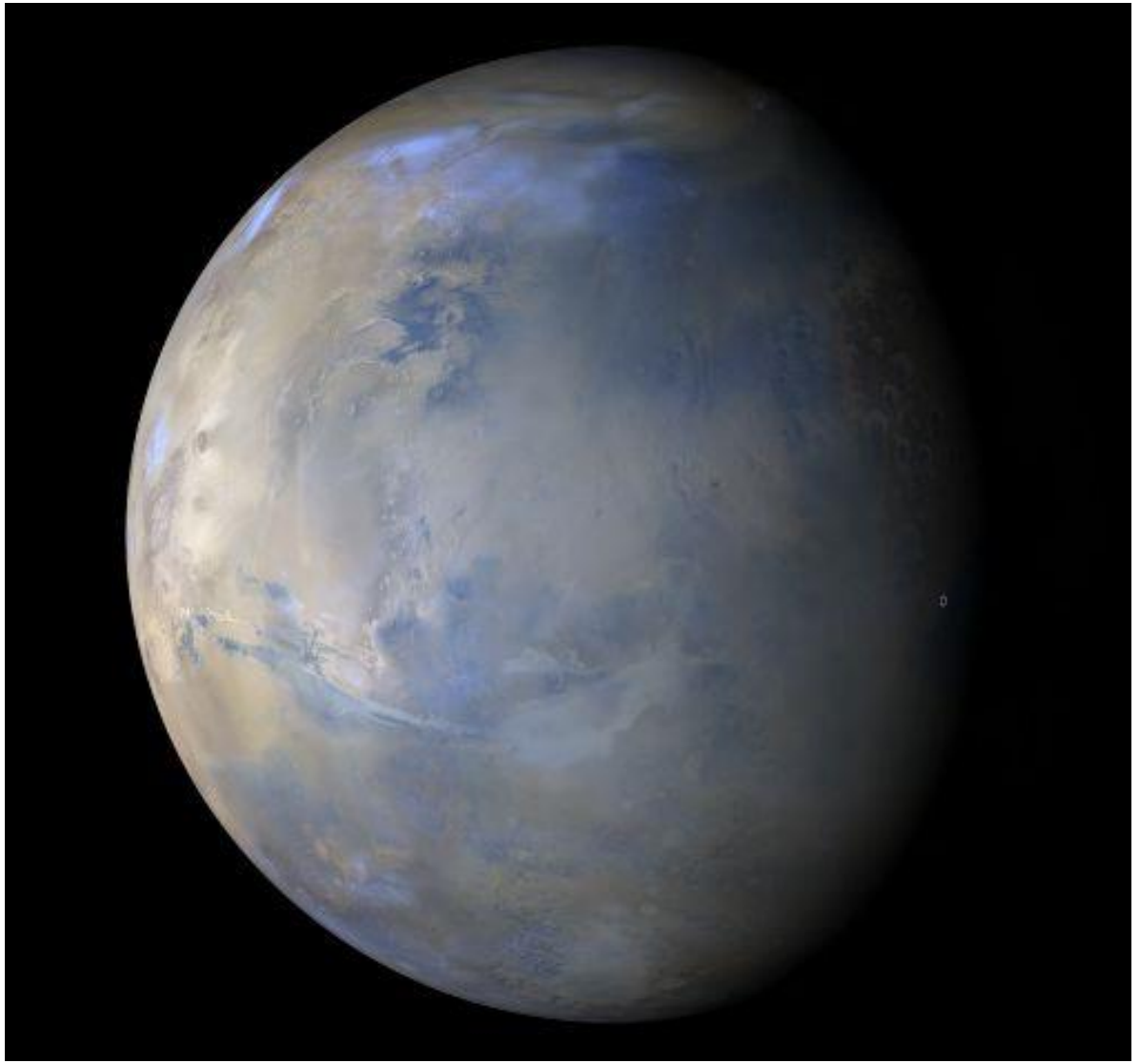
Working with the HRSC team and SSERVI German PI, Ralf Jaumann, as they produce global mosaics and DEMS. MC-11 quad was the first to be produced, and has been integrated into Mars Trek.

Mars Trek
(http://marstrek.jpl.nasa.gov)

Jet Propulsion Laboratory
California Institute of Technology

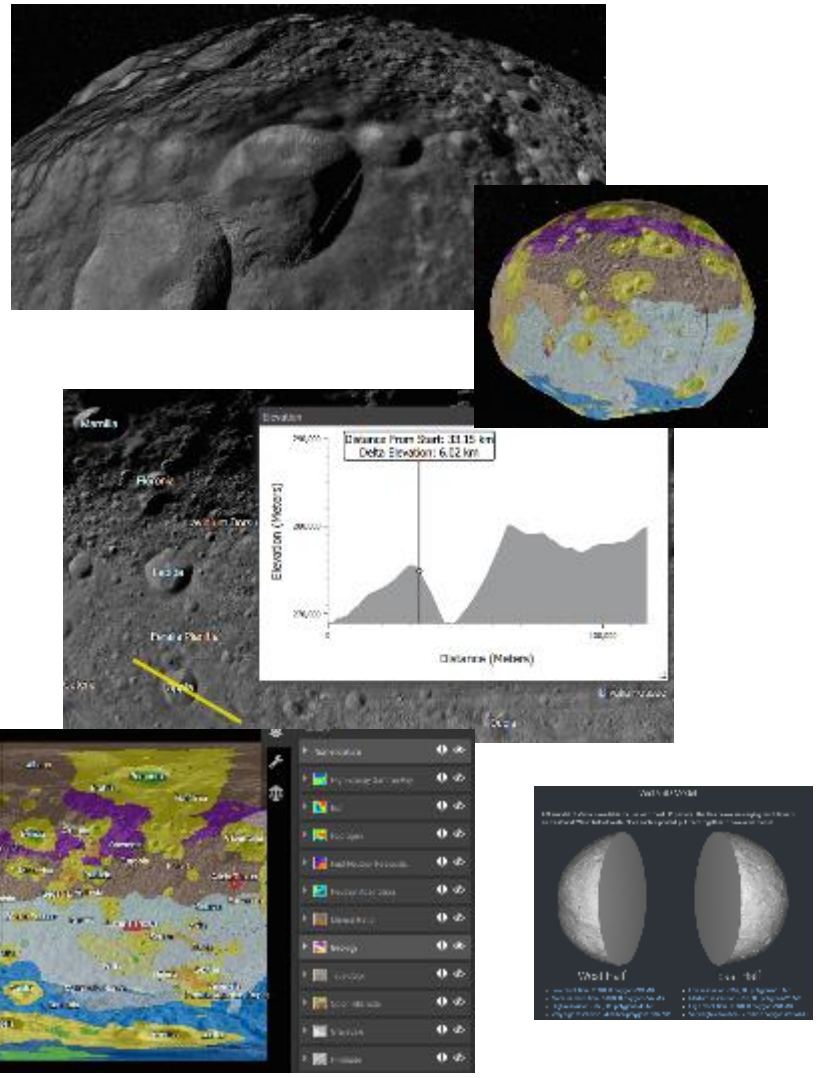
Climate/Weather

- Working with Laura Kerber at JPL on integration of her mapped data products focusing on Mars climate
- Working with Jeff Hollingsworth at NASA Ames to determine ways of representing his weather models
- As we integrate time series capabilities, looking at integration of MARCI daily global images documenting Martian weather



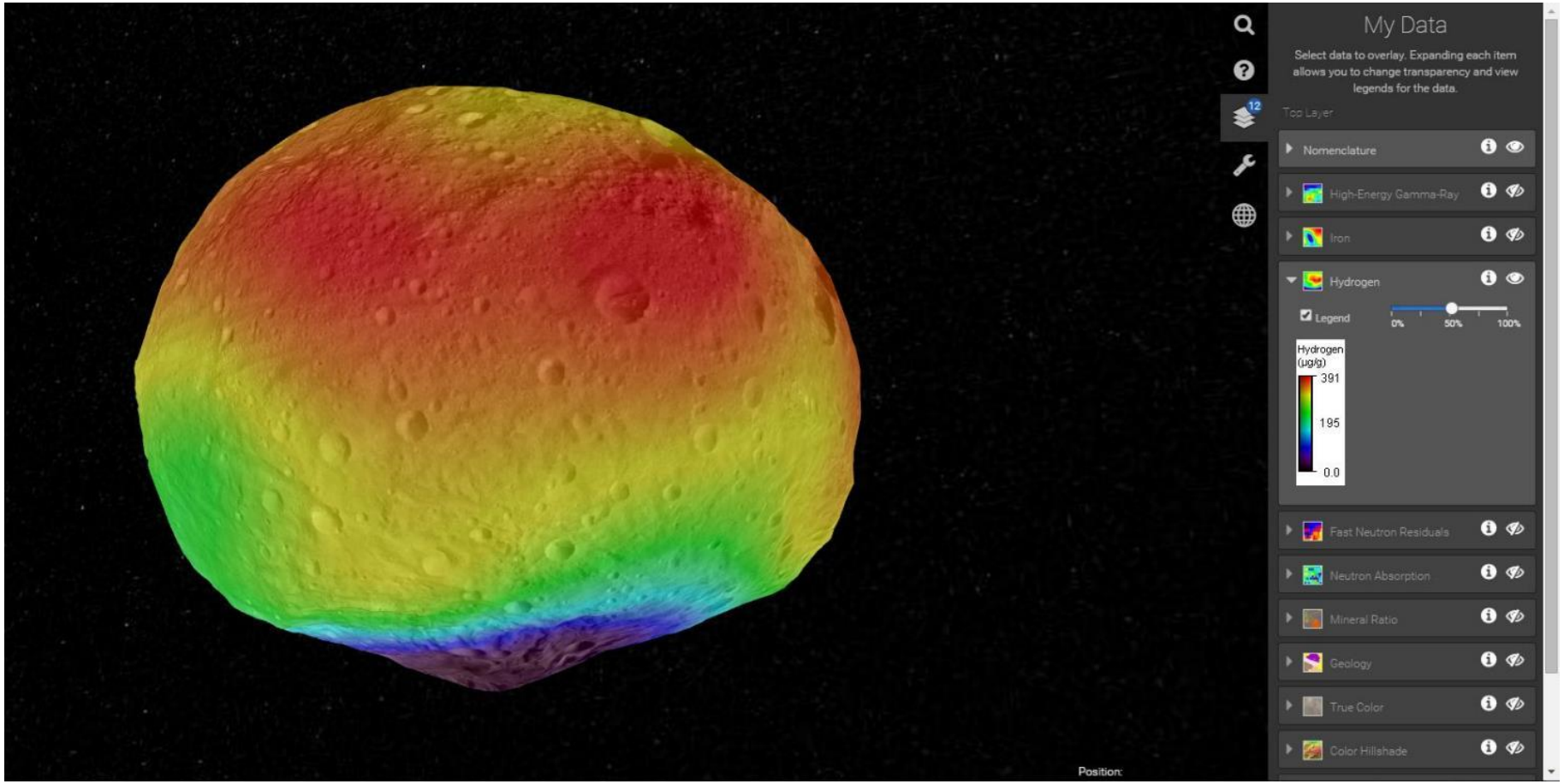
Vesta Trek (https://vestatrek.jpl.nasa.gov)

- Analysis tools
  - Distance, Profile, Sun Angle, Sun and Earth Overhead
- Browse data products
- Visualization (with overlays)
- 3D fly over and printing
- Data
  - Iron, Hydrogen, Neutron, Geology, Hillshade, High-energy Gamma-Ray
- Users
  - EPO, Scientists



Vesta Trek

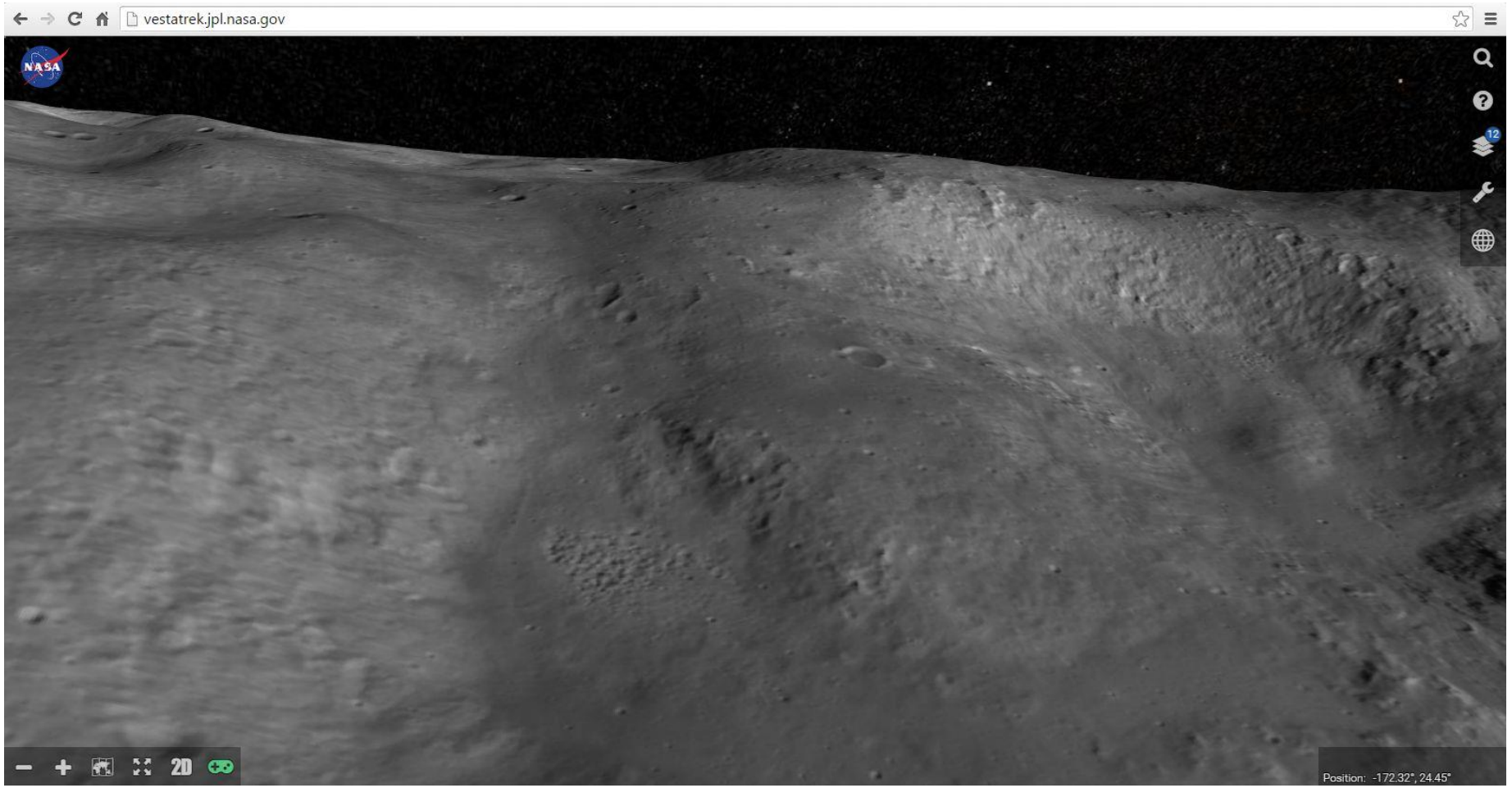
(https://vestatrek.jpl.nasa.gov)



Vesta 3D view with Hydrogen Abundance layer overlaid.

Vesta Trek

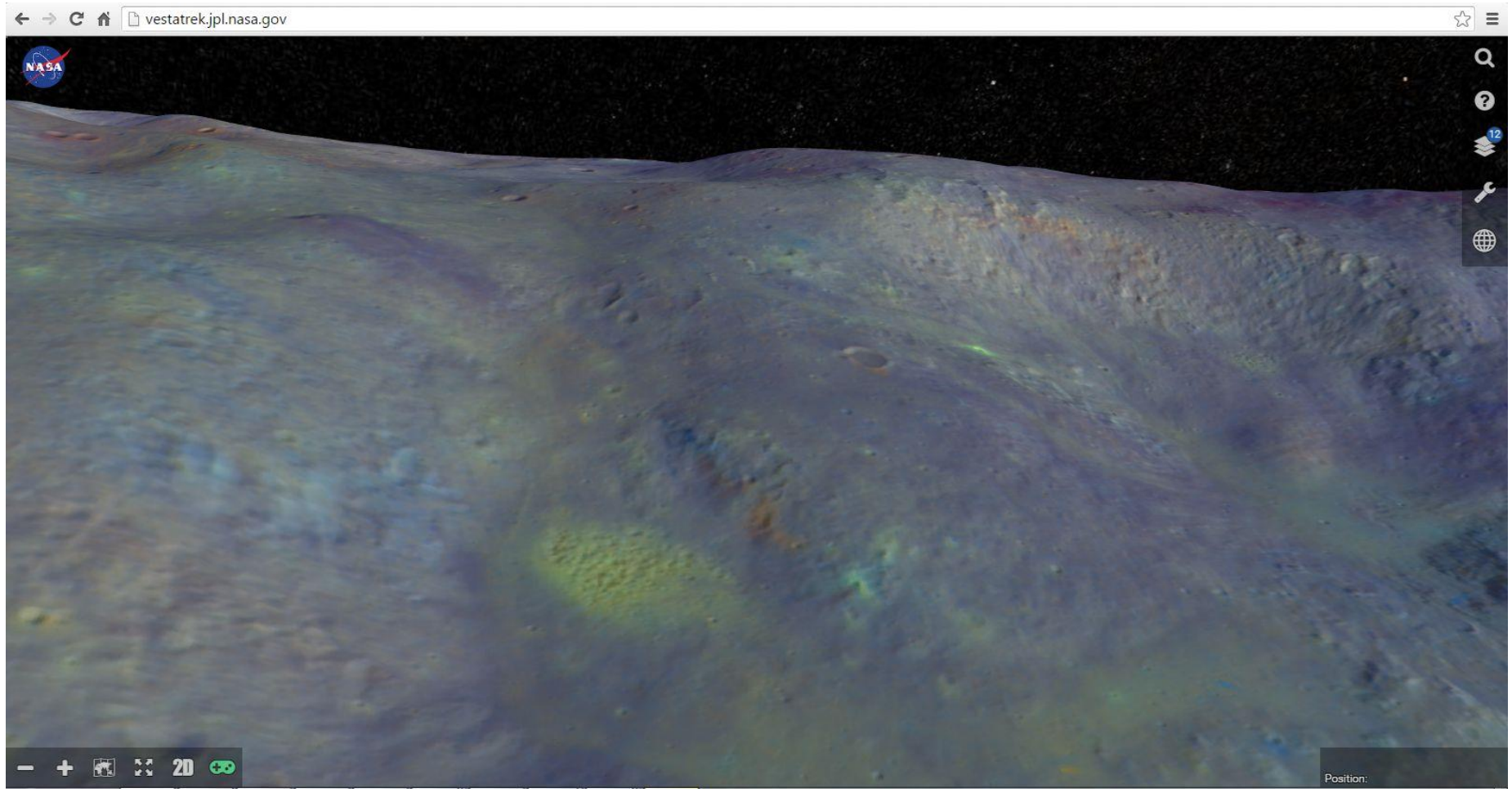
(https://vestatrek.jpl.nasa.gov)



Pitted terrain north of Marcia

Vesta Trek

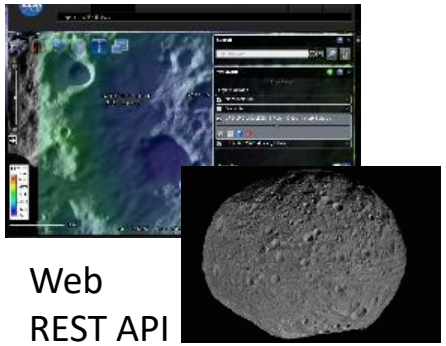
(https://vestatrek.jpl.nasa.gov)



Pitted terrain north of Marcia with the addition of the Vesta Trek Mineral Ratio layer using a mosaic of Dawn HAMO frames with band ratios emulating the Clementine Mineral Ratio Mosaic.

User Experience

Virtual Reality Client



Web
REST API

Touch Table

Outreach

Serving as an Infrastructure Project for SMD STEM Activation

NASA SPACE APPS CHALLENGE

NTL NASA Tournament Lab

2nd year of student HLS2 meetings at Ames

AMERICAN MUSEUM OF NATURAL HISTORY

CALIFORNIA ACADEMY OF SCIENCES

Serving data to Morrison and Hayden planetariums

Support NASA booth exhibits at AGU, NSTA, ALA, Comic Con

CSULA Senior Projects

CAL STATE LA
CALIFORNIA STATE UNIVERSITY, LOS ANGELES

Jet Propulsion Laboratory
California Institute of Technology

Help us improve these portals!

Please let us know of any data products that you have and/or know about which would be of particular value to you to have included.

Thank You!

https://moontrek.jpl.nasa.gov
https://marstrek.jpl.nasa.gov
https://vestatrek.jpl.nasa.gov

Brian H. Day – SSERVI – brian.h.day@nasa.gov
Emily S. Law – JPL – emily.s.law@jpl.nasa.gov

Eddie Arevalo, Bach Bui, George Chang, Natalie Gallegos, Richard Kim, Shan Malhotra, Syed Sadaqathullah, Dan Yu, Quoc Vu